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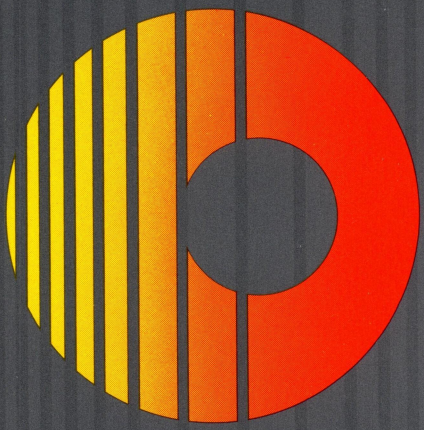
MS™-DOS DISK OPERATING SYSTEM USER'S GUIDE



MS™-DOS
DISK OPERATING SYSTEM

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This manual gives an overview of the MS-DOS operating system, and describes the user interface, the file system, the command structure, and each of the available commands. It also contains chapters on:

EDLIN.COM - the MS-DOS line editor
DEBUG.COM - the MS-DOS debugger
FILCOM.CO. - the MS-DOS file comparison program

System Requirements

The MS-DOS operating system requires an 8086 or 8088 microcomputer system. The operating system itself runs in and requires 32 Kbytes of memory.

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MS-DOS DISK OPERATING SYSTEM

USER'S GUIDE

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CHAPTER 1

INTRODUCTION

The MS-DOS disk operating system is one of Microsoft's family of operating systems for 8086 and 8088 microprocessors. It provides a simple but powerful interface between the user and a computer system's resources. Most all Microsoft languages are available under MS-DOS, including the BASIC Interpreter, the BASIC Compiler, MS-Pascal, and MS-FORTRAN. In addition, the 8-bit versions of Microsoft's languages are upward compatible with the 16-bit versions. Thus, application programs written in 8-bit Microsoft languages can be run under MS-DOS with little or no modification.

1.1 FEATURES AND BENEFITS OF MS-DOS

The following features and benefits make MS-DOS the operating system of choice for 8088 and 8086 microcomputers:

Easy Conversion from 8080 to 8086

MS-DOS allows as much transportability of 8-bit machine language software as is reasonably possible. For instance, MS-DOS emulates system calls to the 8-bit CP/M operating system. Therefore, by simply running assembly language source code through the Intel conversion program, almost all 8080 programs created for the CP/M operating system can be made to work without modification in the MS-DOS environment. In most cases, converting programs from CP/M-80 to MS-DOS is easier than converting to other 16-bit operating systems.

Device Independent I/O

MS-DOS simplifies I/O to different peripheral devices by assigning a reserved filename to each device. These names are built-in to MS-DOS and are detected by the MS-DOS file system. Thus, for example, programs designed only for disk file I/O

can have their input come from the terminal keyboard or their output sent to the printer.

Advanced Error Recovery Procedures

MS-DOS does not necessarily require rebooting when disk errors occur. If a disk error occurs at any time during any program, MS-DOS retries the operation three times. If the operation cannot be completed successfully, MS-DOS returns an error message, then waits for the user to enter a response. Thus, the user can attempt to recover from the error rather than reboot the operating system.

Complete Program Relocatability

The architecture of the 8086 CPU limits each segment of memory to 64K-bytes and requires intersegment references to be fixed for a given load address. MS-DOS works around this limitation through its special executable object module format. During program development, the Microsoft linker can combine object modules created with any of Microsoft's BASIC, Pascal, or FORTRAN compilers or by Microsoft's macro assembler. These modules can be combined to create an executable module requiring any number of segments.

Powerful, Flexible File Characteristics

In MS-DOS, there is no practical limit on file or disk size. MS-DOS uses 4-byte XENIX Operating System compatible logical pointers for a disk capacity of up to 1 gigabyte. (Microsoft's XENIX is a licensed version of the UNIX system. XENIX is available for a variety of 16-bit microcomputer systems through a license agreement from Microsoft.)

MS-DOS remembers the exact physical end-of-file marker. Thus, should one open a file with a logical record length greater than the physical record length, MS-DOS remembers exactly where the file ends to the byte, rather than rounded to 128 bytes.

Written entirely in 8086 Assembly Language

Because it is written entirely in 8086 assembly language, MS-DOS provides significant speed improvements over operating systems that are largely translated from their 8-bit counterparts.

Fast, Efficient File Structure

MS-DOS employs a highly efficient disk structure which eliminates the need for "extents," minimizes access to the directory track, and provides for duplicate directory information and verifications

after writes.

No Need to Log in Disks

As long as no file is currently being written, disks can be swapped without logging in. One benefit of this feature is that the MS-DOS debugger, DEBUG.COM can be used without reloading for different programs on different disks.

No Physical File/Disk Size Limitation

Unlike operating systems that are limited to 8-megabytes per disk, MS-DOS does not require breaking a 24-megabyte hard disk into three separate logical drives.

No Overhead for Non-128-Byte Physical Sectors

Since MS-DOS does its own blocking and deblocking of disk sectors, there is no reason to worry about different physical sector sizes when writing the low level routines for a particular computer system.

Time and Date Stamps

When a file is modified, MS-DOS automatically records the time and date of the modification.

100% IBM Compatible

International Business Machines Corporation has chosen MS-DOS (called IBM Personal Computer DOS) to be the preferred operating system for the IBM Personal Computer. IBM has already announced Microsoft BASIC, Pascal, and FORTRAN along with other accounting, financial planning, and word processing software that runs under MS-DOS.

1.2 PROVIDED SOFTWARE

The software provided with the MS-DOS operating system is described below:

CHKDSK.COM

CHKDSK.COM is a command used to check and verify the contents of a disk. It is further described in Chapter 3, "Commands."

COMMAND.COM

COMMAND.COM is the command interpreter used to interface between the user and the underlying operating system. It allows the user to perform file management functions such as rename and delete, as well as to load and execute programs. COMMAND.COM is further described in Chapter 2, "System Structure."

CREF.EXE

CREF.EXE is the Microsoft MS-CREF cross-reference utility used to create a cross-reference listing from an assembly source listing. CREF.EXE is further described in the Utility Software Package Manual.

DEBUG.COM

DEBUG.COM is a debugger program used to provide a controlled testing environment for executable object files. DEBUG.COM is further described in Chapter 5, "DEBUG."

EDLIN.COM

EDLIN.COM is the MS-DOS line editor. Intraline editing is performed using the special editing keys that are also available at the MS-DOS command level. EDLIN.COM is further described in Chapter 4, "EDLIN."

EXE2BIN.COM

EXE2BIN.COM is used to convert .EXE files to .COM files. In general, only assembly language programs that have been specially formulated may undergo such conversions. EXE2BIN.COM is further described in Chapter 3, "Commands."

FORMAT.COM

FORMAT.COM is used to format disks so that they can be used with MS-DOS. FORMAT.COM is described in Chapter 3, "Commands."

FILCOM.COM

FILCOM is a file comparison program used to check for differences between files. Either text or binary files may be compared. FILCOM is further described in Chapter 6, "FILCOM."

IO.SYS

IO.SYS is the lowest level of the MS-DOS operating system, interfacing to all I/O devices. It is an MS-DOS "hidden file" and does not show up when a directory command is executed. IO.SYS is automatically loaded into memory when your system is booted up. See Chapter 2, "System Structure" for more information.

LIB.EXE

LIB.EXE is the Microsoft MS-LIB library manager used to create, maintain, and manipulate libraries of object files. LIB.EXE is further described in the Utility Software Package Manual.

LINK.EXE

LINK.EXE is the Microsoft MS-LINK linker used to link object files and object libraries to create executable .COM and .EXE files. LINK.EXE is further described in the Utility Software Package Manual.

MASM.EXE

MASM.EXE is Microsoft's relocatable macro assembler for 8086 and 8088 microprocessors, MACRO-86. MASM.EXE is further described in the Utility Software Package Manual.

MSDOS.SYS

MSDOS.SYS is the heart of the MS-DOS operating system, where most management of system resources takes place. MSDOS.SYS is intimately tied to COMMAND.COM and IO.SYS. Note that MSDOS.SYS is an MS-DOS "hidden file" and does not show up when a directory command is executed. MSDOS.SYS is automatically loaded into memory when your system is booted up. For further information, see Chapter 2, "System Structure."

SYS.COM

SYS.COM is used to transfer MSDOS.SYS and IO.SYS from a system disk to a formatted disk that does not contain the MS-DOS operating system on it. It is further described in Chapter 3, "Commands."

1.3 SYSTEM START-UP

To start-up your system, follow your manufacturer's instructions. Next, insert your system disk in drive A:. At this point, your MS-DOS will be booted up and loaded from disk into program memory. A banner then appears containing the MS-DOS version number. Next, COMMAND.COM is loaded into memory and a banner containing it appears. Then you are prompted to set the date and time with the DATE and TIME commands.

For example, you might type:

```
Current time is 00:00:00.00
Enter new time:10:30
Current date is 1-1-80
Enter new date:3-25-82
```

Finally, the MS-DOS prompt appears with the letter of the driver and a colon:

```
A:_
```

The cursor is indicated in this manual with an underline character. At this point you are at the MS-DOS command level and are under the supervision of COMMAND.COM.

The first thing that you should do is create a back-up of your system disk. This is done by first inserting a blank disk into drive B:. Next type:

```
FORMAT B:/S
```

FORMAT formats the disk in drive B: so that it can be used

with MS-DOS. The /S causes hidden system files to be copied to the newly formatted disk after it has been formatted. When FORMAT is done, you should then type:

```
COPY A:*.* B:
```

This command copies all files on the system disk to the new disk. At this point, you should remove the original system disk and store it in a safe place. Use the copy of the system disk from now on.

1.4 SYNTAX NOTATION

The following notation is used throughout this manual in descriptions of command and statement syntax:

[ ] Square brackets indicate that the enclosed entry is optional.

< > Angle brackets indicate user entered data. When the angle brackets enclose lower case text, the user must type in an entry defined by the text; for example, <filename>. When the angle brackets enclose upper case text, the user must press the key named by the text; for example, <RETURN>.

{ } Braces indicate that the user has a choice between two or more entries. At least one of the entries enclosed in braces must be chosen.

... Ellipses indicate that an entry may be repeated as many times as needed.

CAPS Capital letters indicate portions of statements or commands that must be entered exactly as shown. When capital letters appear within angle brackets, they indicate typing of a control character such as <CONTROL-C> or <RETURN>.

All other punctuation, such as commas, colons, slash marks, and equal signs, must be entered exactly as shown.

CHAPTER 2

SYSTEM STRUCTURE

This chapter gives a structural overview of the MS-DOS operating system, describing:

1. System resources
2. The file system
3. The user interface
4. Command types

By acquiring an understanding of each of these subjects, you will gain a sound understanding of the structure of the MS-DOS operating system.

2.1 SYSTEM RESOURCES

Each time your computer is turned on, it normally will "boot up" the operating system by automatically loading MS-DOS from disk into memory. The area of memory in which the operating system is loaded is referred to as system memory.

MS-DOS, itself, consists of three files:

```
COMMAND.COM
MSDOS.SYS
IO.SYS
```

These three files combine to form an operating system that controls all system resources. Note that MSDOS.SYS and IO.SYS are "hidden" files that are not displayed when a directory command is executed. The relationship between these three files and system resources is shown in Figure 2.1.

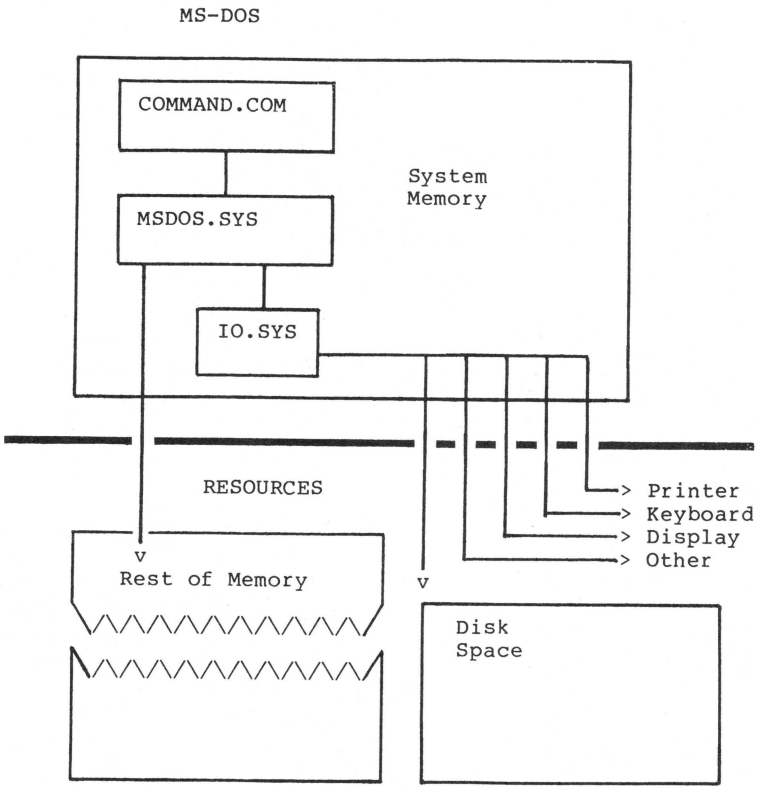


Figure 2.1 MS-DOS and Its Resources

System resources include peripheral devices such as terminals, printers, and serial lines. However, a system's most important system resources are its disk space and its memory--these are described in the following sections.

2.1.1 Disk Space

In MS-DOS, disk space is divided into four parts:

The Reserved Sectors

This region contains information that is used each time MS-DOS is booted up. This information is system dependent, but typically will include a simple bootstrap loader.

The Directory

The directory contains information about each file on a given disk, including the file's complete filename, its size, and its time and date of last modification.

The File Allocation Table

The file allocation table (FAT) contains location information for the data making up each file on a given disk. Note that MS-DOS does not require a file's contents to reside in physically contiguous disk sectors.

Files

The great majority of disk space is reserved for the contents of files. An individual file does not necessarily reside in contiguous sectors on disk, and may be "scattered" in memory to decrease waste of disk space.

2.1.2 Memory

Besides controlling a system's disk space and its other devices, MS-DOS must also control main memory. This means that MS-DOS must be capable of loading files into memory either as data files or as files that are to be executed. The actual loading of files is performed by IO.SYS, the lowest level of the MS-DOS operating system. Loading of executable files is supervised by COMMAND.COM. For most well-designed programs, control is returned to MS-DOS after either normal or abnormal termination of a program.

Note that part of COMMAND.COM may be overlaid to make room for a particularly large executable file. After execution of such a file, MS-DOS automatically loads the overlaid part of COMMAND.COM back into system memory, and normal execution of COMMAND.COM resumes. If the overlaid part of COMMAND.COM is not available on disk because the disk on which it resides has been removed, the following message appears:

```
Insert DOS disk in default drive
and strike any key when ready
```

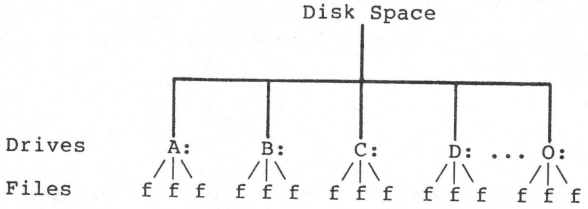
Also, if an incorrect version of COMMAND.COM is found, then a similar message appears:

```
Invalid COMMAND.COM
Insert DOS disk in default drive
and strike any key when ready
```

2.2 FILE SYSTEM

The preceding discussion of system resources discussed many of the internal aspects of the operating system. A file system, on the other hand, can be thought of as the external organization of system resources. It provides a way of talking about files and devices. Note that MS-DOS supports "device independent I/O", which means that the distinction between files and devices is an internal distinction, but not an external one. Therefore, the user can treat files and devices alike, and can refer to either with "filenames."

Note, however, that disk space is special, since it is divided into drives; the disk space in a drive and on a particular disk is further divided into files, as shown below:



Disks are named so that up to 15 can be referred to. They are named with the letters A through O, where each letter is followed by a colon (:). This colon separates the name of the disk from the names of individual files on the disk. This letter-colon combination is called a drive designation.

2.2.1 Naming Conventions

MS-DOS supports a three-part name for files (and devices) called a file specification. A full file specification contains a drive designation, a filename, and a filename extension.

The format of a file specification is:

```
[<d>:]<filename>[.<ext>]
```

The parts of a file specification are described below:

<d>: is the drive designation as described in the preceding section.

<filename> is an internal name consisting of from 1 to 8 characters. Internally, all filenames are exactly 8 characters: this means that filenames with seven or fewer characters have all remaining characters padded with spaces. MS-DOS performs this padding automatically. Legal characters in filenames are:

```
A-Z    0-9    $    &    #    @    !

%    '    (    )    -    <    >

\    ^    {    }    ~    |    `
```

Any of the above characters is legal in any position in the filename. Note that lowercase characters are converted to uppercase wherever they occur in a file specification. This means that a filename such as "FiLe.ExT" is converted to the filename "FILE.EXT."

.<ext> is the filename extension consisting of three or fewer characters. Padding of spaces occurs as described above for filenames. Legal characters are the same as for filenames. All characters are legal in any position in the extension, and all lowercase characters are converted to uppercase characters, just as for filenames. Filenames with no extensions can also be specified by typing only a period after the filename. It is usually only necessary to use this form when a given command requires a default extension.

2.2.2 Wild Card Characters

There are two wild card characters that can be used in file specifications: the asterisk (*) and the question mark (?). By using these characters, a short hand notation is created for specifying multiple files. This notation is particularly useful when file specifications are required as parameters for commands. MS-DOS makes full use of this capability for commands such as the directory, delete, and copy commands: DIR, DEL, and COPY.

The two wild card characters are described below:

? When COMMAND sees a question mark (?), it matches any single character found in that position in a filename.

For example, examine the following command:

```
DEL AB?DE.EXT
```

This directory command deletes all files whose names begin with AB, end with DE, and have the filename extension .EXT. For example, MS-DOS might delete the following files:

```
ABCDE.EXT
ABODE.EXT
ABIDE.EXT
```

* When COMMAND.COM sees an asterisk (*) in a filename parameter, it matches all characters found in those positions in any filename in the appropriate directory. The asterisk (*) is a shorthand for a series of question marks (?). So, for example, the following are equivalent:

```
DEL *.*
DEL ???????.???
```

However, the asterisk is typed more easily.

The command DEL *.* deletes all files stored on the disk in the default drive. regardless of filename or extension.

Here are some other examples, with their equivalents in question mark characters:

```
DEL FILE.*     DEL FILE.???
(Delete all variations of FILE
 regardless of extension)
```

```
DEL *.EXT      DEL ????????.EXT
(Delete all files with the
 filename extension .EXT)

DEL ABC*.E*    DEL ABC?????.E??
(Delete all files whose names
 begin with ABC and that have
 a filename extension that
 begins with .E)
```

2.2.3 Device Filenames

Certain 3-letter filenames are reserved for the names of devices. These names are listed below:

AUX
: Used when referring to input from or output to an auxiliary device.

CON
: Used when referring to either keyboard input or to output to the terminal screen.

LST or PRN
: Used when referring to the line printer.

NUL
: Used when you do not want to create a particular file, but the syntax of a command requires an input or output filename.

Even if given device designations or extensions, these filenames remain associated with the devices listed above. Thus, A:CON.LST still refers to the terminal console and is not the name of a disk file. This device naming scheme permits treating devices as if they were files, and is a consequence of MS-DOS's device independent I/O.

2.3 USER INTERFACE

MS-DOS acts as an interface between the user and a computer system's resources, with communication from the user normally occurring through keyboard input. This keyboard input is the raw data that is used to edit the MS-DOS command line. When editing is complete, the command line is passed on to COMMAND.COM where it is scanned for command names and parameters. Thus, the user interface consists of two levels of processing: command line editing and command interpretation. These levels are discussed in the next two sections.

2.3.1 Command Line Editing

MS-DOS offers a variety of functions that operate on the command line buffer. These functions make command line editing a simple and efficient task, very much in contrast to the nuisance it can be in other operating systems. The command line buffer is intimately related to another buffer called the "template," which is used in many of MS-DOS's special editing functions.

The model for command line input is as follows:

1. When text is entered from the keyboard, it is held in the command line until the <RETURN> key is pressed.

2. Pressing <RETURN> causes the contents of the command line to be sent to COMMAND.COM for processing.

3. Pressing <RETURN> also copies the command line to the template.

Thus, the template always contains the last entered command line.

The command line is altered by entering one the following kinds of input:

Alphanumerics
Punctuation
Special editing functions
Control character functions

Alphanumeric and punctuation characters are entered into the command line as they are typed. Later, COMMAND.COM will convert all lowercase letters to uppercase.

The special editing and control character functions greatly increase MS-DOS's ease of use. All of the MS-DOS commands, from DEBUG to FILCOM, can make use of these functions wherever input is required from a terminal. These functions are always resident in the operating system.

2.3.1.1 Special Editing Functions - Because they depart from the "normal" way in which most operating systems handle command input, the special editing functions deserve particular emphasis. They relieve the user of repeatedly typing in the same sequences of keys because the last command line entered is automatically placed in the template and "remembered."

Therefore, by using the template and executing the special editing functions, you receive the following advantages:

1. A command line can be instantly repeated in two key-strokes.

2. An erroneous command line can be edited and retried, without reentering the entire command line.

3. A command line similar to a preceding command line can be edited and executed with a minimum of typing.

The relationship between the command line and the template is shown in Figure 2.2.

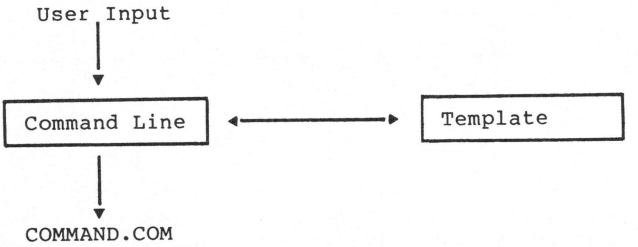


Figure 2.2 The Command Line and the Template

Table 2.1 contains a complete list of the special editing commands. Each command is more fully described in Chapter 4, "EDLIN," where these special editing commands become a subset of the commands available within the MS-DOS editor, EDLIN, and are called the intraline editing commands.

Note that the special editing commands may be assigned to the keys that make the best use of a specific terminal keyboard. Therefore, each command is identified by a functional name rather than by a specific key code. For an application on a specific terminal, the codes are configured for specific terminal keys.

Table 2.2 MS/DOT Special Editing Functions

MS Key	DOT Key	Editing Function
<C1>	F1	Copy one character from the template to the command line
<CM>	F2	Copy all characters up to the character specified from the template to the command line
<CT>	F3	Copy all remaining characters in the template to the command line
<S1>	DEL	Skip over (do not copy) a character in the template
<SM>	F4	Skip over (do not copy) the characters in the template up to the character specified
<QI>	F6	Void the current input; leave the template unchanged
<INS>	INS	Enter insert mode
<REP>	INS	Exit insert mode (toggle from insert); this is the default
<NT>	F5	Make the new line the new template
	F8	Backspace

As an example of the use of the special editing keys and command entry in general, pretend that you have entered the following command:

```
DIR PROG.COM<RETURN>
```

This command displays contents of the file PROG.COM on the terminal screen. It also has the useful side effect of saving the command line in the template. To repeat the command, all you have to do is type two keys: <CT> and <RETURN>.

The repeated command is displayed on the screen, as you type, as shown below:

```
<CT>DIR PROG.COM<RETURN>
```

Note that pressing the <CT> key causes the contents of the template to be copied to the command line buffer; pressing <RETURN> causes the command line to be processed by COMMAND.COM.

Now pretend that you want to display the contents of the file PROG.ASM. To do this we will make use of the template, and type

```
<CM>C
```

Entering <CM>C copies characters from the template to the command line buffer up to the character "C":

```
DIR PROG._
```

Note that the underline is your cursor. Now type:

```
.ASM
```

The result is:

```
DIR PROG.ASM_
```

The desired command line is now in the command line buffer. To send this command line on to COMMAND.COM, the command interpreter, simply enter <RETURN>.

The template now contains the following command line:

```
DIR PROG.ASM
```

Now assume that we want to execute the following command:

```
TYPE PROG.ASM
```

To do this, we type:

```
TYPE<INS> <CT><RETURN>
```

Note that normal alphanumeric characters are entered directly into the command line buffer, automatically replacing corresponding characters in the template. This automatic replacement is turned off when the <INS> key is typed. Thus, the characters "TYPE" replace the characters "DIR " in the template. To insert a space between "TYPE" and "PROG.ASM," we first typed <INS> and then a space. Finally, to copy the rest of the template to the command line, we typed <CT>, followed by a <RETURN>.

When <RETURN> is typed, the entire command line is copied to the template, in this case:

```
TYPE PROG.ASM
```

If we had misspelled "TYPE" as "BYTE", a command error would occur. Still, instead of throwing away the whole command line, we could have saved the mistyped command line (before typing <RETURN>) by creating a new template with the <NT> key:

```
BYTE PROG.ASM<NT>
```

We could then edit this erroneous command line by typing:

```
T<Cl>P<CT>
```

The <Cl> key copies a single character from the template to the command line buffer. The resulting command line then is what we want:

```
TYPE PROG.ASM
```

As an alternative, we could have used the same template containing BYTE PROG.ASM, and used the <Sl> and <INS> commands to achieve the same result:

```
<Sl><Sl><Cl><INS>YP<CT>
```

To illustrate how the command line buffer is affected as you type, examine the keys typed on the left and their affect on the contents of the command line buffer, shown on the right:

```
<Sl>          _                  {Skips over 1st template char}
<Sl>          _                  {Skips over 2nd template char}
<Cl>          T_                 {Copies 3rd template char}
<INS>YP       TYP_               {Inserts two characters}
<CT>          TYPE PROG.ASM_     {Copies rest of template}
```

Note that <Sl>, like <SM>, does not affect the command line buffer; rather, it effects the template by deleting the first character in the template. Similarly, <SM> deletes characters in the template up to a given character (this character is the next one typed).

As you can see from the above examples, these special editing function keys can add greatly to your effectiveness at the keyboard. The next section describes control character functions that complement the above functions.

2.3.1.2 Control Character Functions - While commands are being entered, MS-DOS recognizes seven control character functions. These control characters and the functions associated with them are shown in Table 2.2.

Table 2.2 Control Character Functions

Control Character	Function
<CONTROL-N>	Cancel echoing of output to line printer.
<CONTROL-C>	Abort current command.
<CONTROL-H>	Remove last character from command line, and erase character from terminal screen.
<CONTROL-J>	Insert physical end-of-line, but do not empty command line. Use Linefeed to extend the current logical line beyond the physical limits of one terminal line.
<CONTROL-P>	Echo terminal output to the line printer.
<CONTROL-S>	Suspend display of output to terminal screen. Press any key to resume.
<CONTROL-X>	Cancel the current line, empty the command line, and then output a back slash (\), carriage return, and line feed. The template used by the Special Editing commands is not affected.

2.3.2 Command Interpretation

The MS-DOS user interface permits editing of command lines with the special editing and control character functions described in the preceding section. Once a command line has been edited, it is sent to COMMAND.COM for processing. COMMAND.COM is the hub of the operating system, acting as the interface between the lower levels of the operating system and user input. It is in COMMAND.COM that the commands that are entered on the command line are interpreted.

Commands themselves are of one of two types: either internal or external. Internal commands are all resident in memory as part of COMMAND.COM; they are loaded into memory when the operating system is booted up. External commands, on the other hand, are loaded into memory from disk only when needed. External commands reside in disk files that have a name with either a .COM or .EXE extension. Note that COMMAND.COM itself is an external command. A picture of the command interface is shown in Figure 2.3.

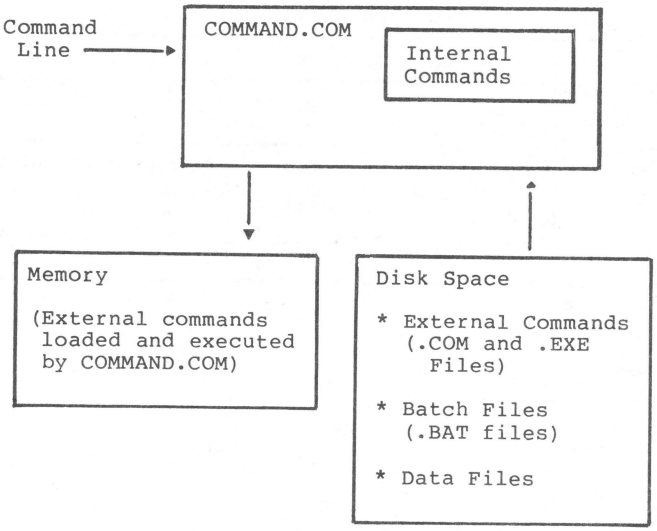


Figure 2.3 MS-DOS Command Structure

Command interpretation begins when COMMAND.COM scans the command line for the name of a legal command. If it is an internal command, it is executed immediately; if it is a batch file, commands are executed indirectly from a .BAT

file; if it is an external .COM or .EXE command, the appropriate file is loaded from disk into memory where it is executed. (The batch facility and .BAT commands are discussed later in this chapter.)

COMMAND.COM provides MS-DOS' characteristic colon prompt (:) in the form of a drive designation letter and a colon (:).

For example:

```
A:_
```

The cursor is the focus of any editing actions that you perform. The cursor is indicated by an underline in this manual; the symbol itself is implementation dependent.

At system start-up, the default prompt is always A:. After start-up, the user may specify the default (that is, the currently selected drive). To select a new drive, simply enter the designation letter followed by a colon:

```
A:_                 (prompt; default drive)
A:B:<RETURN>        (user enters new drive designation)
B:_                  (new prompt; new default drive)
```

Note that COMMAND's main goals are to identify commands typed at the command line and then to execute them. All commands consist of a command name followed by optional parameters. When parameters are present, they must be separated from the command name and from each other. Spaces, tabs, and commas are the only legal separators.

For example:

```
COPY OLDFILE.REL,NEWFILE.REL

RENAME THISFILE THATFILE
```

COMMAND.COM is able to execute several different types of commands: these types are described later in this chapter.

2.4 COMMAND TYPES

COMMAND.COM allows you to execute four different types of commands:

1. Internal commands such as DIR, REN, TYPE and DEL.
2. .COM commands such as CHKDSK.COM, DEBUG.COM, and EDLIN.COM.
3. .EXE commands such as LINK.EXE, MASM.EXE, and CREF.EXE.
4. .BAT command files that contain multiple instances of the above commands.

The internal commands and the simplest, most commonly used external commands are described in Chapter 3, "Commands." You should study all of these commands carefully.

Use of the MS-DOS batch facility is discussed in the next section of this chapter. The batch facility allows you to indirectly execute a set of commands contained in a file. This facility allows you to tailor commands for a particular purpose without a great deal of programming effort.

Separate chapters are also provided on three utility programs:

EDLIN - The MS-DOS line editor
DEBUG - The MS-DOS debugger
FILCOM - The MS-DOS file comparison program

Finally, most of the .EXE files provided with the MS-DOS operating system are described in the Utility Software Package Manual. The programs described in this manual make up a powerful and complete assembly language development system.

This software includes:

MASM.EXE - The MACRO-86 macro assembler for 8088 and 8086 microprocessors
LINK.EXE - The MS-LINK linker
CREF.EXE - The MS-CREF assembler cross-reference utility
LIB.EXE - The MS-LIB library manager facility

2.4.1 Internal Commands

Internal commands are incorporated in COMMAND.COM and are always available when COMMAND.COM is resident in memory. Unlike the external commands, discussed in the next section, these commands need not be available on disk when they are executed. Note that most internal commands are simple and easy to use. This is in contrast to some of the external commands which are larger and more complex.

The internal commands are listed below. Each is described thoroughly in the next chapter.

COPY	REN
DATE	PAUSE
DEL	TIME
DIR	TYPE
REM	

2.4.2 External Commands

Any file with the filename extension .COM or .EXE is considered valid as an external command. Such commands are executed by entering the name of the file less its .COM or .EXE extension. Programs that you create with most languages will be .EXE files.
External commands include:

ASM86	EXE2BIN
CHKDSK	FORMAT
COMMAND	FILCOM
CREF	LINK
DEBUG	LIB
EDLIN	SYS

Note that .EXE files created with the MACRO-86 assembler can be converted to .COM files with the command EXE2BIN.EXE. The format of a .COM file is special, so .EXE files cannot be arbitrarily converted. Note also that all .COM commands execute in less than 64K of memory; .EXE files, on the other hand, may require more than 64K of memory to execute.

2.4.3 Batch Commands

The MS-DOS batch facility allows files containing commands to be submitted for processing internally by MS-DOS. "Batches" of commands in such files are processed as if they were typed at a terminal. Each batch file must be named with the .BAT extension, and is submitted for execution by entering its filename less that extension. Optional parameters may be given as well. Therefore, the invocation syntax is as follows:

```
<filespec>[<parameters>]
```

By creating a .BAT file with prototype commands containing positional parameters, parameters may be passed to the .BAT file when it is executed. You may specify up to 10 positional parameters, named %0 through %9.

Positional parameters are substituted in their order on the invocation line for corresponding occurrences in the batch file. If the dummy parameter %0 is used, the batch facility substitutes the name of the batch command itself for parameter %0. Thus, the batch facility permits creation of batch commands that can be used on more than just one set of files, and that can be used to reexecute themselves.

For example, a batch file might look like this when viewed from within EDLIN, the MS-DOS line editor:

```
1: REM This is file NEWDISK.BAT
2: REM   (the .BAT extension must be given)
3: PAUSE  Insert disk in B:
4: FORMAT B:/S
5: DIR B:
6: CHKDSK B:
```

To execute this .BAT file, simply enter the filename without the .BAT extension:

```
NEWDISK
```

The result is the same as if each of the lines in the .BAT file were entered at the terminal as individual commands.

To pass parameters to the .BAT file, the user must create a .BAT file containing prototype commands with dummy entries.

For example:

```
1: REM This is A:ASMFILE.BAT
2: REM START BATCH FILE
3: COPY %1.ASM %2.ASM
4: MASM %2,%2,%2;
5: TYPE %2.PRN
6: TYPE %0.BAT
```

Assume that this file exists as A:ASMFILE.BAT.

To execute this .BAT file and pass parameters, enter:

```
A:ASMFILE A:MYPROG B:MYPROG
```

The result is the same as if you had entered each of the following commands at your terminal:

```
REM This is A:ASMFILE.BAT
REM START BATCH FILE
COPY A:MYPROG.ASM B:MYPROG.ASM
MASM B:MYPROG,B:MYPROG,B:MYPROG;
TYPE B:MYPROG.PRN
TYPE A:ASMFILE.BAT
```

When you boot up your system, COMMAND.COM searches for the file A:AUTOEXEC.BAT. If a file with that name exists on disk, then the batch facility is automatically invoked to execute the commands contained in AUTOEXEC.BAT. In such a case, execution of the TIME and DATE commands at start-up is bypassed. If COMMAND.COM does not find AUTOEXEC.BAT, then the normal MS-DOS prompt is displayed instead.

Two MS-DOS commands are available expressly for their use in batch files: REM and PAUSE. REM permits the inclusion of remarks and comments in batch files; PAUSE prompts the user with an optional message and permits either continuing or aborting execution of a batch file at a given point. REM and PAUSE are further described in Chapter 3, "Commands."

CHAPTER 3

COMMANDS

NOTE

Users of single-drive systems should refer to Appendix A for the additional procedures required when executing many of the following commands.

The following notation is used in the descriptions in this chapter.

filespec Refers to an optional drive designation followed by a filename followed by a period and an optional three letter filename extension. For example:

B:ABODE.BAS	(refers to a disk file on disk B:)
FILE.BAS	(refers to a disk file on the default disk)
CON	(refers to the user's terminal console)
CON.BAS	(same as above)

filename Refers to any valid name for a disk file, including an optional extension. A filename parameter does not refer to a device or to a disk drive designation alone.

d: Refers to a disk drive designation

All of the commands described in this chapter are listed below:

CHKDSK	Scan the directory of the default or designated drive and check for consistency.
COPY	Copy file(s) specified.
DATE	Display and set date.
DEL	Delete files specified. ERASE is a synonym for this command.
DIR	List requested directory entries.
EXE2BIN	Convert .EXE file to a .COM file.
FORMAT	Format a disk to receive MS-DOS files.
PAUSE	Pause for input in a batch file.
REM	Display a comment in a batch file.
REN	Rename first file as second file. RENAME is a synonym for this command.
SYS	Transfer MS-DOS system files from drive A: to the drive specified.
TIME	Display and set time.
TYPE	Display the contents of file specified.

NAME | TYPE

CHKDSK | External

SYNTAX

CHKDSK [d:]

FUNCTION

Scan the directory of the default or designated drive and check it for consistency.

COMMENTS

CHKDSK should be run occasionally on each disk to verify the integrity of the directory structure. If any errors are found, the appropriate error message is displayed and corrective action is attempted.

After the disk has been checked, CHKDSK displays error messages, if any, and then a status report.

A sample status report follows:

```
160256  bytes total disk space
  8192  bytes in 2 hidden files
 30720  bytes in 8 user files
121344  bytes available on disk

 65536  bytes total memory
 53152  bytes free
```

If an error is detected, CHKDSK returns one of the following error messages:

Allocation error for file <filename>
: The named file had a data block allocated to it that did not exist (that is, a data block number larger than the largest possible block number). CHKDSK truncates the file short of the bad block.

Disk not initialized
: No directory or file allocation table was found. If files exist on the disk, and the disk has been physically harmed, it may still be possible to transfer files from this disk to recover data.

Directory error-file: <filename>
: No valid data blocks are allocated to the named file. CHKDSK deletes the file.

Files cross-linked: <filename> and <filename>
The same data block is allocated to both files. No corrective action is taken. To correct the problem, first use the COPY command to make copies of both files; then, delete the originals. Review each file for validity and edit as necessary.

File size error for file <filename>
The size of the file in a directory is different from its actual size. The size in the directory is automatically adjusted to indicate its actual size on the disk. (The amount of useful data may be less than the size shown because the last data block may not be used fully.)

XXXXXX bytes of disk space freed
Disk space shown as allocated was not actually allocated and has been freed.

COPY

NAME

COPY

TYPE

Internal

SYNTAX

COPY filespec [filespec]

FUNCTION

Copy the first filespec to the second.

COMMENTS

If the second filespec parameter is not given, the copy is on the default drive and has the same name as the original (first filespec parameter). If the first filespec is on the default drive and the second filespec is not given, the COPY is aborted. (Copying files to themselves is not allowed.) MS-DOS returns the error message:

```
File cannot be copied onto itself
0 File(s) copied
```

The second parameter may take three forms. If the second parameter is a drive designation (d:) only, the original file is copied with the same name to the designated drive. If the second parameter is a filename only, the original file is copied to a file with the name specified on the default drive. If the second parameter is a full filespec, the original file is copied to a file with the name specified on the designated drive.

The COPY command also allows file concatenation while copying. Concatenation is invoked by simply listing any number of files as parameters to COPY, separated by "+".

For example,

```
COPY  A.XYZ + B.COM+B:C.TXT BIGFILE.CRP
```

The above command concatenates the contents of A.XYZ, B.COM, and B:C.TXT and places them in the file on the default drive called BIGFILE.CRP.

The concatenation operation is normally carried out in text (or ASCII) mode, meaning a <CONTROL-Z> (1A hex) in the file is interpreted

as the end-of-file mark. To combine binary files, this interpretation of the end-of-file may be overridden with the /B switch, which forces the command to use the physical end-of-file as the end of file (that is, the file length seen in the DIR command).

For example,

```
COPY/B A.COM + B.COM
```

Also, in the above example, no resulting file name was given. In this case, COPY seeks to the end of A.COM and appends B.COM to it, leaving the result named A.COM.

ASCII and binary files may be arbitrarily combined by using /B on binary files and /A on ASCII files. A switch (/A or /B) takes effect on the file it is placed after and applies to all subsequent files until another switch is found.

A /A or /B switch on the destination file determines whether or not a <CONTROL-Z> is placed at the end of the file. (Source files read while /A is in effect have <CONTROL-Z> stripped off. If /A is in effect when the file is written, a single <CONTROL-Z> will be put back.) Thus, an additional <CONTROL-Z> would be appended with a command such as:

```
COPY  A.ASM/B B.ASM/A
```

This occurs because the /B on the first file prevents the <CONTROL-Z> from being stripped, and the /A on the second puts one on. The primary practical application may be the reverse, where a <CONTROL-Z> is stripped from the file.

For example:

```
COPY PROG.COM/B + ERRS.TXT/A NEWPROG.COM/B
```

It is assumed here that ERRS.TXT was generated by an editor, but is actually considered constant data (error messages) by the program it is being appended to. Since the result is a .COM file, a <CONTROL-Z> at the end is not needed.

Even when not concatenating files, the /A and /B switches are still processed. When not concatenating, the copy command defaults to binary copy. By using the /A switch, the result file may be truncated at the first end-of-file mark:

```
COPY A.TXT/A B.TXT
```

B.TXT may be shorter than A.TXT if A.TXT contained an embedded <CONTROL-Z>. B.TXT will have exactly one <CONTROL-Z>, the last character of the file.

Concatenation with ambiguous file names is allowed, and the COPY command normally "does what you want". To combine several files specified with an ambiguous name into one file, use a command like:

```
COPY  *.LST  COMBIN.PRN
```

All files matching *.LST are combined into one file called COMBIN.PRN. Another type of task is performing several individual concatenations:

```
COPY  *.LST + *.REF *.PRN
```

In this example, for each file found matching *.LST, that file is combined with the corresponding .REF file, with the result given the same name but with the extension .PRN. Thus, FILE1.LST will be combined with FILE1.REF to form FILE1.PRN, then XYZ.LST with XYZ.REF to form XYZ.PRN, and so on. The following COPY command combines all files matching *.LST, then all files matching *.REF, into one file call COMBIN.PRN:

```
COPY *.LST + *.REF COMBIN.PRN
```

It is easy to enter a concatenation COPY command where one of the source files is the same as the destination, yet this often cannot be detected. For example, the following command is an error if ALL.LST already exists:

```
COPY  *.LST  ALL.LST
```

This is not detected, however, until it is ALL.LST's turn to be appended. At this point it could already have been destroyed.

COPY handles this problem like this: as each input file is found, its name is compared with the destination. If they are the same, that one input file is skipped, and the message "Content of destination lost before copy" is printed. Further concatenation proceeds normally. This allows "summing" files, with a command like

```
COPY  ALL.LST + *.LST
```

This command appends all *.LST files, except ALL.LST itself, to ALL.LST. The error message is suppressed in this case, since this is produced by a true physical append to ALL.LST.

DATE

NAME
DATE

TYPE
Internal

SYNTAX
DATE [<mm>-<dd>-<yy>]

FUNCTION
Display and set the date.

COMMENTS
If entered without a parameter, DATE returns with the message:

```
Current date is <mm>-<dd>-<yy>
Enter new date:_
```

Press <RETURN> if you do not want to change the date shown.

Optionally, the date may be given as a parameter to the DATE command as in:

```
DATE 3-9-81
```

In this case, no message appears.

The new date must be entered using numerals only: letters are not permitted. The allowable parameters are:

```
<mm> = 1-12
<dd> = 1-31
<yy> = 80-99 or 1980-2099
```

The date, month, and year entries may be separated by hyphens (-) or slashes (/). MS-DOS is programmed to change months and years correctly, whether the month has 31, 30, 29, or 28 days. (Note that MS-DOS handles leap years, too.)

If the parameters or separators are not legal, MS-DOS returns the message:

```
Invalid date
Enter new date:_
```

DATE then waits for entry of a legal date.

DEL

NAME

DEL

TYPE

Internal

SYNTAX

DEL filespec

FUNCTION

Delete all the files with the filespec specified.

COMMENTS

If the filename is *.*, the prompt "Are you sure?" appears. If a "Y" or "y" is typed as a response, then all files are deleted as requested. ERASE is a synonym for this command.

DIR

NAME
DIR

TYPE
Internal

SYNTAX
DIR [filespec][/P][/W]

FUNCTION
List the files in a directory

COMMENTS
If no parameter is present (DIR), all directory entries on the default drive are listed. If only the drive specification is present (DIR d:), all entries on the disk in the specified drive are listed. If only filename is present (DIR filename) with no extension, then all files with the filename specified on the disk in the default drive are listed. If a full file specification is present (DIR d:filename.ext), all files with the filename specified on the disk in the drive specified are listed. In all cases, files are listed with their size in bytes and the time and date of their last modification.

The wild card characters question mark (?) and asterisk (*) may be used in the filename parameter. Refer to Section 2.2.2, "Filenames," for examples of the use of the wild card characters. Note that for the convenience of the user, the following invocations of the DIR command are equivalent:

COMMAND	EQUIVALENT
DIR	DIR *.*
DIR FILE	DIR FILE.*
DIR .EXT	DIR *.EXT
DIR .	DIR *.

Two switches may be given with DIR. The /P switch selects Page Mode. With /P, display of the directory pauses after the screen is filled. To resume display of output, type any key.

The /W switch selects Wide Display. With /W, only file names are displayed without other file information. Files are displayed five per line.

EXE2BIN

NAME

EXE2BIN

TYPE

External

SYNTAX

EXE2BIN filespec [d:][filename][.ext]

FUNCTION

Convert files from .EXE format to binary format

COMMENTS

The first parameter is the input file; if no extension is given, it defaults to .EXE. The second parameter is the output file. If no drive is given, the drive of the input file is used; if no filename is given, the filename of the input file is used; if no extension is given, .BIN is used.

The input file must be in valid .EXE format produced by the linker. The "resident", or actual code and data part of the file, must be less than 64K. There must be no STACK segment. Two kinds of conversion are possible depending on the specified initial CS:IP:

1. If CS:IP is not specified, a pure binary conversion is assumed. If segment fix-ups are necessary, the following prompt appears:

   Fix-up needed - base segment (hex):

   By typing a legal hexadecimal number and then <RETURN>, execution will continue.

2. If CS:IP is specified as 100H, then it is assumed the file is to be run as a .COM file ORGed at 100H, and the first 100H of the file is to be deleted. No segment fix-ups are allowed, as .COM files must be segment relocatable.

If CS:IP does not meet one of these criteria or meets the .COM file criterion, but has segment fix-ups, the following error message is displayed:

File cannot be converted

Note that to produce standard .COM files with the MACRO-86 assembler, one must both ORG the file at 100H and specify the first location as

the start address (this is done in the END statement).

For example:

```
        ORG     100H
START:
          .
          .
          .
        END     START
```

FORMAT

NAME

FORMAT

TYPE

External

SYNTAX

FORMAT d:[/S]

FUNCTION

Format the disk in the drive designated to accept MS-DOS files.

COMMENTS

Initialize the directory and file allocation tables. The reserved sectors are copied onto track 0, sector 1. (This occurs whether or not the /S switch is given.)

If the /S switch is present, FORMAT copies operating system files from the disk in the default drive to the newly formatted disk. The files copied are copied in the following order:

IO.SYS
MSDOS.SYS
COMMAND.COM

PAUSE

NAME
PAUSE

TYPE
Internal

SYNTAX
PAUSE [comment]

FUNCTION
Suspend execution of the batch file.

COMMENTS
During the execution of a batch file, you may need to change disks or to perform some other action between the execution of batch commands. The PAUSE command exists for just such purposes. PAUSE suspends execution until you type any key, except <CONTROL-C>.

When COMMAND encounters PAUSE, it prints:

```
Strike a key when ready . . .
```

Pressing any key except <CONTROL-C> resumes execution of the batch file. If you type <CONTROL-C>, another prompt is displayed:

```
Abort batch job (Y/N)?
```

If you type "Y" in response to this prompt, execution of the remainder of the batch command file is aborted and control returns to the operating system command level. Therefore, PAUSE can be used to break a batch file into pieces, allowing you to end the batch command file at an intermediate point.

The optional comment may be entered on the same line as PAUSE. You may also want to prompt the user of the batch file with some meaningful message when the batch file has paused. For example, you may want to change disks in one of the drives. An optional prompt message may be given in such cases. The comment prompt is displayed before the "Strike a key" message.

REM

NAME

REM

TYPE

Internal

SYNTAX

REM [comment]

FUNCTION

Display remark entered on same line as REM when encountered during execution of batch file.

COMMENTS

The REM command has no other effect. The only delimiters for the comment are any one of the three legal delimiters to start the comment (blank space, tab, comma).

REN

NAME
REN

TYPE
Internal

SYNTAX
REN filespec filename

FUNCTION
Change the name of the first parameter (filespec) to the second parameter (filename).

COMMENTS
The first parameter (filespec) must be given a drive designation if the file disk resides in a drive other than the currently logged (default) drive. Any drive designation for the second parameter (filename) is ignored. The file will remain on the disk where it currently resides.

The wildcard characters, question mark (?) and asterisk (*), may be used in either parameter. All files matching the first filespec are renamed. If wildcard characters appear in the second name, corresponding character positions are not changed.

For example, the following command changes the names of all files with the .LST extension to similar names with the .PRN extension:

```
REN *.LST *.PRN
```

Another example causes the file ABODE on drive B: to be renamed ADOBE:

```
REN B:ABODE ?D?B?
```

The file remains on drive B:.

An attempt to rename a file to a name already present in the directory will result in the error message "Duplicate file name or file not found."

Note that RENAME is a synonym for the REN command.

SYS

NAME
SYS

TYPE
External

SYNTAX
SYS d:

FUNCTION
Transfer the MS-DOS system files from the disk in the default drive to the drive specified by d:.

COMMENTS
SYS is normally used to update a system or to place the system on a formatted disk that contains no files. An entry for d: is required.

The target disk must either be completely blank or already have the hidden system files IO.SYS and MSDOS.SYS (see below). If this is not the case, SYS will report "No room for system on destination disk."

If IO.SYS and MSDOS.SYS are present, they must take up the same amount of space on the disk as the new system will need. If they do not, SYS will report "Incompatible system size."

The files transferred are copied in the following order:

IO.SYS
MSDOS.SYS

Note that COMMAND.COM is not transferred and that IO.SYS and MSDOS.SYS are both hidden files that do not appear when the DIR command is executed.

TIME

NAME
TIME

TYPE
Internal

SYNTAX
TIME [<hh>[:<mm>[:<ss>]]]

FUNCTION
Display and set the time.

COMMENTS
If the TIME command is entered without any parameters, then the following message is displayed:

```
Current time is <hh>:<mm>:<ss>.<cc>
Enter new time:_
```

Simply type <RETURN> if you do not want to change the time shown. Optionally, a new time may be given as a parameter to the TIME command as in:

```
TIME 8:20:00
```

The new time must be entered using numerals only: letters are not allowed. The allowable parameters are:

```
<hh> = 00-24
<mm> = 00-59
<ss> = 00-59
```

The hour, minute, and second entries must be separate by colons.

MS-DOS uses whatever time is entered as the new time as long as the parameters and separators are legal. If the parameters or separators are not legal, MS-DOS returns the message:

```
Invalid time
Enter new time:_
```

MS-DOS then waits for entry of a legal time.

TYPE

NAME

TYPE

TYPE

Internal

SYNTAX

TYPE filespec

FUNCTION

Display the contents of the file on the console screen.

COMMENTS

Use this command to examine a file without modifying it. Use DIR to find the name of a file and EDLIN to alter the contents of a file. The only formatting performed by TYPE is that tabs are expanded to spaces consistent with tab stops every eighth column. Note that display of binary files causes control characters to be sent to your computer, including bells, formfeeds, and escape sequences.

CHAPTER 4

EDLIN

EDLIN is a text editor used to edit files that are divided into lines. Each line may be up to 255 characters, the last character of each being the end of line character, the carriage return. Line numbers are not actually present in saved text, but when a file is displayed, lines are numbered dynamically. When a file is created or edited, line numbers begin at 1 and are incremented by one through the end of the file. When new lines are inserted between existing lines, all line numbers following the inserted text are automatically incremented by the number of lines inserted. When lines are deleted between existing lines, all line numbers following the deleted text are decremented automatically by the number of lines deleted. Consequently, lines numbers always run from 1 through n (the last number).

4.1 INVOCATION

To invoke EDLIN, enter:

```
EDLIN <filespec>
```

If the file specified exists, EDLIN loads the file into memory. If the whole file is loaded, EDLIN returns the message "End of input file" and an asterisk (*) prompt. If the file is "larger than memory", then EDLIN fills 3/4 of available memory with the first part of the file and then returns the asterisk (*) prompt, but not the "End of input file" message. (This is just like the Append command with no parameter. See Section 4.3, "Interline Commands," for more information on Append.)

You may then edit the existing file. When you want to edit the part of a file that is not in memory, you must first write out to disk some of the file that is in memory, and then append lines into memory. (See the A and W commands.)

If the file specified does not exist, EDLIN creates the file and returns the message NEW FILE. and then displays the asterisk (*) prompt, indicating that the editing session may begin.

IMPORTANT

> When creating a new file, be sure to specify on which drive the file should be saved. The command to end the editing session and save the file does not allow parameters. Therefore, if the drive is not designated during EDLIN invocation, the file is saved on the default drive.

EDLIN commands belong to two types: intraline and interline. Intraline commands perform editing functions within a single line. The commands used to perform intraline editing are the control character functions and the special editing commands discussed in Chapter 2. The special editing functions are described in more detail in the following section than they were in Chapter 2. Note, however, that these are the same commands that are used at the MS-DOS command level. The only difference between them is that the EDLIN commands operate on the line currently being edited, rather than the MS-DOS command line.

4.2 INTRALINE COMMANDS

Intraline commands include the special editing functions and the control character functions: only the special editing functions are discussed here. See Section 2.3.1.2 for more information on the control character functions.

The special editing commands all may be assigned to the keys that make the best use of a specific terminal keyboard. Therefore, each command is identified by a functional name rather than by a specific key, and each is configurable to a particular keyboard key code. A code has been given to each command for ease of reference during the examples which demonstrate the function. (For an application on a specific terminal, the codes should be replaced by the names of the specific terminal keys.) Table 4.1 summarizes the commands, codes, and functions. Descriptions of the special editing functions follow the table.

Table 4.1 Special Editing Commands

Command	Code	Function
Copy One character	<C1>	Copy one character from the template to the new line
Copy up to character	<CM>	Copy all characters from the template to the new line up to the character specified
Copy Template	<CT>	Copy all remaining characters in the template to the new line
Skip One character	<S1>	Do not copy (skip over) a character in the template
Skip up to character	<SM>	Do not copy (skip over) the characters in the template up to the character specified
Quit Input	<QI>	Void the current input; leave the template unchanged
Insert mode	<INS>	Enter insert mode
Replace mode	<REP>	Exit insert mode (toggle from insert); this is the default
New Template	<NT>	Make the new line the new template

<Cl>

KEY

<Cl>

FUNCTION

Copy one character from the template to the input buffer.

COMMENTS

Pressing the <Cl> key copies one character from the template to the input buffer. When the <Cl> key is pressed, one character is inserted in the buffer and insert mode is automatically turned off if it was on. Use the <Cl> key to advance the cursor one column across the line.

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Pressing the <Cl> key copies the first character (T) to the second of the two lines displayed:

```
     1:*This is a sample file
<Cl> 1:*T_
```

Each time the <Cl> key is pressed, one more character appears:

```
<Cl> 1:*Th_
<Cl> 1:*Thi_
<Cl> 1:*This_
```

KEY

<CM>

FUNCTION

Copy multiple characters up to a given character

COMMENTS

Pressing the <CM> key copies all characters up to a given character from the template to the input buffer. The given character is the next character typed and is not copied or shown on the screen. Pressing the <CM> key causes the cursor to move to the single character that is this command's only parameter. If the template does not contain the specified character, nothing is copied. Pressing <CM> also automatically turns off insert mode if it is on.

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Pressing the <CM> key copies all characters up to the character pressed immediately after the <CM> key.

```
          1:*This is a sample file
<CM>p 1:*This is a sam_
```

<CT>

KEY

<CT>

FUNCTION

Copy template to input buffer

COMMENTS

Pressing <CT> copies all remaining characters from the template to the input buffer. Regardless of the cursor position at the time the <CT> key is pressed, the rest of the line appears, and the cursor is positioned after the last character on the line.

EXAMPLE:

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Pressing the <CT> key copies all characters from the template (shown in the upper line displayed) to the line with the cursor (the lower line displayed):

```
     1:*This is a sample file
<CT> 1:*This is a sample file._
```

Also, insert mode is automatically turned off if it was on.

<Sl>

KEY

<Sl>

FUNCTION

Skip over one character in the template

COMMENTS

Pressing the <Sl> key skips over one character in the template. Each time you press the <Sl> key, one character is deleted (not copied) from the template. The action of the <Sl> key is similar to the <Cl> key, except that <Sl> skips a character in the template rather than copies it to the input buffer.

EXAMPLE:

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Pressing the <Sl> key skips over the first character ("T").

```
     1:*This is a sample file
<Sl> 1:*_
```

The cursor position does not move, only the template is affected. To see how much of the line has been (skipped over), press the <CT> key, which moves the cursor beyond the last character of the line.

```
     1:*This is a sample file.
<Sl> 1:*_
<CT> 1:*his is a sample file._
```

<SM>

KEY

<SM>

FUNCTION

Skip multiple characters in the template

COMMENTS

Pressing the <SM> key skips over all characters up to a given character in the template. The given character is the next character typed, and is not copied and not shown on the screen. If the template does not contain the specified character, nothing is skipped over. The action of the <SM> key is similar to the <CM> key, except that <SM> skips over characters in the template rather than copies them to the input buffer.

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Pressing the <SM> key skips over (deletes) all the characters in the template up to the character pressed after the <SM> key:

```
        1:*This is a sample file
<SM>p 1:*_
```

The cursor position does not move. To see how much of the line has been skipped over, press the <CT> key to copy the template. This moves the cursor beyond the last character of the line:

```
        1:*This is a sample file:
<SM>p 1:*_
<CT>  1:*ple file._
```

<QI>

KEY

<QI>

FUNCTION

Quit input and flush the input buffer.

COMMENTS

Pressing the <QI> key flushes the input buffer, but it leaves the template unchanged. <QI> also prints a back slash (\), carriage return, and line feed, and turns insert mode off if it was on. The cursor is positioned at the beginning of the line. Pressing the <CT> key copies the template to the input buffer just as the line was before <QI> was pressed.

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Assume you want to replace the line by typing:

```
                1:*This is a sample file.
Sample File 1:*Sample File_
```

Now, to reedit the line, press <QI>:

```
     1:*This is a sample file.
<QI> 1:*Sample File\
     1:_
```

<RETURN> can now be pressed to keep the original line or to perform any other intraline editing functions. If <CT> is pressed, the original template is copied to the input buffer:

```
<CT> 1: This is a sample file._
```

<INS>

KEY

<INS>

FUNCTION

Enter insert mode

COMMENTS

Pressing the <INS> key causes entry into insert mode. The current position in the template is not changed. The cursor does move as each character is inserted. However, when you have finished inserting characters, the cursor is positioned at the same character as it was before the insertion began. Thus, characters are inserted before the character the cursor points to.

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Assume you press the <CM> and "p" keys:

```
        1:*This is a sample file
<CM>p   1:*This is a sam_
```

Now press the INS key and insert the three characters "s", "o", and "n".

```
          1:*This is a sample file.
<CM>p     1:*This is a sam_
<INS>son  1:*This is a samson_
```

If you now press the <CT> key, the rest of the template is copied to the line:

```
      1:*This is a samson_
<CT>  1:*This is a samsonple file._
```

If you were to press the <RETURN> key, instead, the remainder of the template would be truncated, and the input buffer ended at the end of the insert:

```
<INS>son<RETURN>  1:*This is a samson
```

<REP>

KEY

<REP>

FUNCTION

Enter Replace mode.

COMMENTS

Pressing the <REP> key causes exit from insert mode and entry into replace mode. All characters entered overstrike and replace characters in the template. (Replace mode is the default.) When you start to edit a line, this mode is in effect. Each character typed replaces a character in the template. If the <RETURN> key is pressed, the remainder of the template is truncated.

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Assume you then press <CM>p, <INS>son, <REP>ite, and then <CT>:

```
                1:*This is a sample file.
<CM>p           1:*This is a sam_
<INS>son        1:*This is a samson_
<REP>ite        1:*This is a samsonite_
<CT>            1:*This is a samsonite file._
```

If you type in characters that extend beyond the length of the template, the remaining characters in the template are automatically appended when you type <CT>.

<NT>

KEY

<NT>

FUNCTION

Create new template

COMMENTS

Pressing the <NT> Key copies the current contents of the input buffer to the template. The contents of the old template are then destroyed. Pressing <NT> outputs an at sign character (@), a carriage return, and a line feed. The input buffer is also emptied and insert mode is turned off.

NOTE

<NT> performs the same functions as the <QI> key, except that the template is changed and an at sign character (@) is printed instead of a backslash (-).

EXAMPLE

Assume the screen shows:

```
1:*This is a sample file.
1:*_
```

At the beginning of the intraline edit, the cursor is positioned at the beginning of the line (indicated by the underline). Assume that you enter <CM>p, <INS>son, <REP>ite, and then <CT>:

```
                1:*This is a sample file.
<CM>p           1:*This is a sam_
<INS>son        1:*This is a samson_
<REP>ite        1:*This is a samsonite_
<CT>            1:*This is a samsonite file._
```

At this point, assume that you want this line as the new template, so you press the <NT> key:

```
<NT> 1:*This is a samsonite file.@
     _
```

Additional editing can now be done using the above new template.

4.3 INTERLINE COMMANDS

Interline commands perform editing functions on whole lines at a time. The interline commands are summarized in the following list and are described in detail with examples following the description of command parameters.

Table 4.1 Interline Commands

Command	Purpose
<line>	Edit Line
A	Append Lines
D	Delete Lines
E	End Editing
I	Insert Text
L	List Text
Q	Quit Editing
R	Replace Text
S	Search Text
W	Write Lines

4.3.1 Parameters

Each interline command accepts some optional parameters. The following list of parameters indicates their form. The effect of a parameter depends on the command it is used with.

PARAMETER DEFINITION

<line> <line> indicates a line number to be entered by the user. Line numbers must be separated from other line numbers, other parameters, and the command. Use a comma or space to separate.

<line> may be specified one of three ways:

Number any integer less than 65534. If a number larger than the largest existing line number is specified, then <line> indicates the line after the last line number.

Period (.) If a period is specified for <line>, then <line> indicates the current line number. The current line is the last line edited, and not necessarily the last line displayed. The current line is marked on your screen by an asterisk (*) between the line number and the first character.

Pound (#) The pound sign indicates the line after the last line number. Specifying # for <line> has the same effect as specifying a number larger than the last line number.

<RETURN> A carriage return entered without any of the <line> specifiers listed above directs EDLIN to use a default value appropriate to the command.

? The question mark parameter directs EDLIN to ask the user if the correct string has been found. The question mark is used only with the Replace and Search commands. Before continuing, EDLIN waits for either a "Y" or <RETURN> for a yes response, or for any other key for a no response.

<string> <string> represents text to be found, to be replaced, or to replace other text. The <string> parameter is used only with the Search and Replace commands. Each <string> must be terminated by a <CONTROL-Z> or a <RETURN> (see the Replace command for details). No spaces should be left between strings or between a string and its command letter, unless you want spaces as part of a string.

<line> Edit

NAME

Edit

SYNTAX

[<line>]

FUNCTION

Edit line

COMMENTS

When a line number is entered, EDLIN displays the line number and text, then, on the line below, reprints the line number. The line is then ready for editing. You may use any of the available intraline commands to edit the line. The existing text of the line serves as the template until the <RETURN> key is pressed.

If no line number is entered (that is, only the <RETURN> key is pressed), the line after the current line, marked with an asterisk (*), is edited. If no changes of the current line are needed and the cursor position is at the beginning or end of the line, press the <RETURN> key to accept the line as is.

WARNING

> If the <RETURN> key is pressed while the cursor is in the middle of the line, the remainder of the line is truncated.

EXAMPLE

Assume the following file exists and is ready to edit:

```
1: This is a sample file.
2: used to demonstrate
3: the editing of line
4:* four.
```

To edit line 4, enter:

```
4
```

<line> Edit

The contents of the line are displayed along with a cursor below the line:

```
4:* four.
4:*_
```

Now type:

```
<INS>number  4: number_
<CT><RETURN> 4: number four.
             5:*_
```

(A)ppend

NAME

Append

SYNTAX

[<n>]A

FUNCTION

Append lines from input file to editing buffer

COMMENTS

Use this command for extremely large files that will not fit into memory all at one time. By writing out part of the editing buffer to the output file with the Write command, room is made for lines to be appended with the Append command. If A is typed without a parameter, lines are appended to the part of the file currently in memory until available memory is 3/4 full or until there are no more lines to append.

Use the W command to write out lines to the output file. If the parameter <n> is given, then <n> lines are appended to that part of the file that currently is in memory. If <n> is not given, then as much of the input file as possible is read into the editing buffer until the editing buffer is three quarters full.

(D)elete

NAME

Delete

SYNTAX

[<line>][,<line>] D

FUNCTION

Delete the specified lines and all lines in between

COMMENTS

If the first <line> is omitted, the first <line> defaults to the current line (the line with the asterisk next to the line number). If the second <line> is omitted, then just the first <line> is deleted. When lines have been deleted, the line immediately after the deleted section becomes the current line and has the same line number as the first <line> had before the deletion occurred.

EXAMPLE

Assume the following file exists and is ready to edit:

```
   1: This is a sample file.
   2: Use: to demonstrate dynamic line numbers
   3: See what happens when you
   4: Delete and Insert
    .
    .
    .
  25: (The D and I commands)
  26: (Use <CONTROL-C> to exit insert mode)
  27:*Line numbers
```

To delete multiple lines, enter <line>,<line> D:

```
5,24 D
```

The result is:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: Delete and Insert
5*(The D and I commands)
6: (Use <CONTROL-C> to exit insert mode)
7: Line numbers
```

(D)elete

To delete a single line, enter:

```
6 D
```

The result is:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: Delete and Insert
5: (The D and I commands)
6:*Line numbers
```

Next, delete a range of lines from the following file:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3:*See what happens when you
4: Delete and Insert
5: (The D and I commands)
6: (Use <CONTROL-C> to exit insert mode)
7: Line numbers
```

To delete beginning with the current line, enter:

```
,6 D
```

The result is:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3:*Line numbers
```

(E)nd

NAME

End

SYNTAX

E

FUNCTION

End the editing session

COMMENTS

Save the edited file on disk, rename the original input file "filename.BAK", and then exit EDLIN to the MS-DOS command level. If the file was created during the editing session, no .BAK file is created.

The E command takes no parameters. Therefore, you cannot tell EDLIN on which drive to save the file. The drive must be selected when the editing session is invoked. If the drive is not designated when EDLIN was invoked, the file is saved on the disk in the default drive. (It will still be possible to COPY the file to a different drive. However, this is done automatically if the drive is designated during invocation.)

You must be sure that the disk contains enough free space for the entire file to be written. If the disk does not contain enough free space, the write is aborted and the edited file lost, although part of the file may be written out.

EXAMPLE

The only possible command is:

```
E<RETURN>
```

After execution of the E command, control is returned to COMMAND.COM and the MS-DOS prompt is displayed.

(I)nsert

NAME

Insert

SYNTAX

[<line>] I

FUNCTION

Insert line(s) of text immediately before the specified <line>.

COMMENTS

If you are creating a new file, the I command must be given before text can be inserted. In this case, the insert begins with line number 1.

EDLIN remains in insert mode until a <CONTROL-Z> or a <CONTROL-C> is entered. Successive line numbers appear automatically each time <RETURN> is pressed. When the insert is finished and insert mode has been exited, the <line>, which now immediately follows the inserted lines, becomes the current line. All line numbers following the inserted section are incremented by the number of lines inserted.

If <line> is not specified, the default is the current line number (the lines are inserted immediately before the current line). If <line> is an integer larger than the last line number, or if # is specified as <line>, the inserted lines are appended to the end of the file. In this case, the last line inserted becomes the current line. (This is the same as when the file is being created.)

EXAMPLE

Assume the following file exists and is ready to edit:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: Delete and Insert
5: (The D and I commands)
6: (Use <CONTROL-C> to exit insert mode)
7:*Line numbers
```

(I)nsert

To insert text before a specific line (not the current line), enter <line> I:

```
4 I
```

The result is:

```
4:_
```

Now, enter the new text for lines 4 and 5:

```
4: fool around with
5: those very useful commands that
```

Then to end the insertion, type:

```
6: <CONTROL-Z>
```

Now type L to list the file; the result is:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: fool around with
5: those very useful commands that
6:*Delete and Insert
7: (The D and I commands)
8: (Use <CONTROL-C> to exit insert mode)
9: Line numbers
```

To insert lines immediately before the current line, enter:

```
I
```

The result is:

```
6: _
```

Now, insert the following text terminated with a <CONTROL-Z>:

```
6: perform the two major editing functions,
```

Now to List the file and see the result, type:

```
L
```

(I)nsert

The result is:

```
    1: This is a sample file.
    2: Use: to demonstrate dynamic line numbers
    3: See what happens when you
    4: fool around with
    5: those very useful commands that
    6: perform the two major editing functions,
    7:*Delete and Insert
    8: (The D and I commands)
    9: (Use <CONTROL-C> to exit insert mode)
   10: Line numbers
```

To append new lines to the end of the file, enter:

```
    11 I
```

This produces the following:

```
    11: _
```

Now, enter the following new lines:

```
    11: The insert command can place new lines
    12: anywhere in the file; there's no space problems.
    13: because the line numbers are dynamic;
    14: They'll slide all the way to 65533.
```

End insertion by typing <CONTROL-C>. The new lines will appear at the end of all previous lines in the file. Now enter the list command:

```
    L
```

The result is:

```
    1: This is a sample file.
    2: Use: to demonstrate dynamic line numbers
    3: See what happens when you
    4: fool around with
    5: those very useful commands that
    6: perform the two major editing functions,
    7: Delete and Insert
    8: (The D and I commands)
    9: (Use <CONTROL-C> to exit insert mode)
   10: Line numbers
   11: The insert command can place new lines
   12: anywhere in the file; there's no space problems.
   13: because the line numbers are dynamic;
   14: They'll slide all the way to 65533.
```

(L)ist

NAME

List

SYNTAX

[<line>][,<line>] L

FUNCTION

List the specified range of lines, including the two lines specified.

COMMENTS

If the first <line> is omitted, the first <line> defaults to the current line. If the second <line> is omitted, 23 lines are listed; the eleven lines before <line>, the <line>, and the eleven lines after <line>. The current line remains unchanged. If the current line is one of the lines listed, it contains an asterisk between the line number and the first character.

EXAMPLE

Assume the following file exists and is ready to edit:

```
 1: This is a sample file.
 2: Use: to demonstrate dynamic line numbers
 3: See what happens when you
 4: Delete and Insert
 5: (The D and I commands)
  .
  .
  .
15:*The current line contains an asterisk.
  .
  .
  .
26: (Use <CONTROL-C> to exit insert mode)
27: Line numbers
```

To list a range of lines without reference to the current line, enter <line>,<line> L:

```
2,5 L
```

The result is:

```
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: Delete and Insert
5: (The D and I commands)
```

(L)ist

To list a range of lines beginning with the current line, enter ,<line> L:

```
,26 L
```

The result is:

```
15:*The current line contains an asterisk.
   .
   .
   .
26: (Use <CONTROL-C> to exit insert mode)
```

To list a range of 23 lines around a specified line, enter <line>, L:

```
13, L
```

The result is:

```
13: The specified line is listed first in the range.
14: The current line remains unchanged by the L command.
15:*The current line contains an asterisk.
   .
   .
   .
35: <CONTROL-C> exits interline insert command mode.
```

To list a range of 23 lines centered around the current line, enter only L:

```
L
```

The result is:

```
 2: Use: to demonstrate dynamic line numbers
 3: See what happens when you
 4: Delete and Insert
 5: (The D and I commands)
  .
  .
  .
13: The current line is listed in the middle of the range.
14: The current line remains unchanged by the L command.
15:*The current line contains an asterisk.
  .
  .
  .
24: <CONTROL-C> exits interline insert command mode.
```

(Q)uit

NAME

Quit

SYNTAX

Q

FUNCTION

Quit the editing session, do not save any editing changes, and exit to the MS-DOS operating system.

COMMENTS

No .BAK file is created. The Q command takes no parameters. It is simply a fast means of exiting an editing session. As soon as the Q command is given, EDLIN displays the message:

```
Abort edit (Y/N)?_
```

Press "Y" to quit the editing session;press "N" (or any other key except <CONTROL-C>) if you decide to continue the editing session.

EXAMPLE

Assume the following file exists and is ready to edit:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: Compare the before and after
4: See what happens when you
5: Delete and Insert
6: Line numbers
```

Now, to delete line 3, enter:

```
3 D
```

To list the file, enter "L":

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: Delete and Insert
5: Line numbers
```

(Q)uit

Now, to keep the changes and to quit the editing session, enter:

```
Q
```

The result is:

```
Abort edit (Y/N)?_
```

Enter "Y" to exit to the operating system command level:

```
Abort edit (Y/N)?Y
A:_
```

(R)eplace

NAME

Replace

SYNTAX

[<line>][,<line>] [?] R<stringl><CONTROL-Z><string2>

FUNCTION

Replace all occurrences of <stringl> in the specified range with <string2>.

COMMENTS

As each occurrence of <stringl> is found, it is replaced by <string2>. Each line in which a replacement occurs is displayed. If a line contains two or more replacemments of <stringl> with <string2>, then the line is displayed once for each occurrence. When all occurrences of <stringl> in the specified range are replaced by <string2>, the R command terminates and the asterisk prompt reappears.

If a second string is to be given as a replacement, then <stringl> must be terminated with a <CONTROL-Z>. If the <string2> is to be omitted, then <stringl> may be terminated with either a combination <CONTROL-Z><RETURN>, or simply a <RETURN>. <String2> must also be terminated with a <CONTROL-Z><RETURN> combination or with a simple <RETURN>. If <stringl> is omitted, then the replacement is terminated immediately. If <string2> is omitted, then <stringl> is deleted from all lines in the range. If the first <line> is omitted in the range argument (as in ,<line>) then the first <line> defaults to the line after the current line. If the second <line> is omitted (as in <line> or <line>,) the second <line> defaults to #. Therefore, this is the same as <line>,#. Remember that # indicates the line after the last line of the file.

If the question mark (?) parameter is given, the Replace command stops at each line with a string that matches <stringl>, displays the line with <string2> in place, and then displays the prompt "O.K.?". If the user presses "Y" or the <RETURN> key, then <string2> replaces <stringl>, and the next occurrence of <stringl> is found. Again, the "O.K.?" prompt is displayed. This process continues until the end of the range or until the end of the file. After the last occurrence of <stringl> is

found, EDLIN returns the asterisk prompt.

If you press any key besides "Y" or <RETURN> after the "O.K.?" prompt, the <string1> is left as it was in the line, and the Replace goes to the next occurrence of <string1>. If <string1> occurs more than once in a line, each occurrence of <string1> is replaced individually, and the "O.K.?" prompt is displayed after each replacement. In this way, only the desired <string1> is replaced, and you prevent replacement of embedded strings.

EXAMPLE

Assume the following file exists and is ready for editing:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: fool around with
5: those very useful commands that
6: perform the two major editing functions,
7: Delete and Insert
8: (The D and I commands)
9: (Use <CONTROL-C> to exit insert mode)
10: Line numbers
11: The insert command can place new lines
12: anywhere in the file; there's no space problems.
13: because the line numbers are dynamic;
14: They'll slide all the way to 65533.
```

To replace all occurrences of <string1> with <string2> in a specified range, enter:

```
2,12 Rand<CONTROL-Z>or<RETURN>
```

The result is:

```
5: those very useful commors that
7: Delete or Insert
8: (The D or I commands)
8: (The D or I commors)
11: The insert commor can place new lines
```

Note that in the above replacement, some unwanted substitutions have occurred. To avoid these, and confirm each replacement, the same original file can be used:

```
      .
      .
    5: those very useful commands that
      .
    7: Delete and Insert
    8: (The D and I commands)
      .
   11: The insert command can place new lines
      .
      .
```

only with a slightly different command. This time, to replace only certain occurrences of the first <string> with the second <string>, enter:

```
2? Rand<CONTROL-Z>or<RETURN>
```

The result is:

```
5: those very useful commors that
O.K.? N
7: Delete or Insert
O.K.? Y
8: (The D or I commands)
O.K.? Y
8: (The D or I commors)
O.K.? N
11: The insert commor can place new lines
O.K.? N
*_
```

Now, enter the List command (L) to see the result of all these changes:

```
      .
      .
    5: those very useful commands that
      .
    7: Delete or Insert
    8: (The D or I commands)
      .
   11: The insert command can place new lines
      .
      .
```

(S)earch

NAME

Search

SYNTAX

[<line>][,<line>] [?] S<string>

FUNCTION

Search the specified range of lines for the specified string.

COMMENTS

The <string> must be terminated with a <RETURN>. The first line that matches <string> is displayed and becomes the current line. The Search command terminates when a match is found. If no line contains a match for <string>, the message "Not found" is displayed.

If the optional parameter, question mark (?), is included in the command, EDLIN displays the first line with a matching string; it then prompts the user with the message "O.K.?". If the user presses either the "Y" or <RETURN> key, the line becomes the current line and the search terminates. If the user presses any other key, the search continues until another match is found, or until all lines have been searched (then the "Not found" message is displayed).

If the first <line> is omitted (as in ,<line> S<string>), the first <line> defaults to the line after the current line. If the second <line> is omitted (as in <line> S<string> or <line>, S<string>), the second <line> defaults to #, which is the same as <line>,# S<string>. If <string> is omitted, no search is made and the command terminates immediately.

EXAMPLE

Assume the following file exists and is ready for editing:

```
1: This is a sample file.
2: Use: to demonstrate dynamic line numbers
3: See what happens when you
4: fool around with
5: those very useful commands that
6: perform the two major editing functions,
7: Delete and Insert
8: (The D and I commands)
```

```
 9: (Use <CONTROL-C> to exit insert mode)
10: Line numbers
11: The insert command can place new lines
12: anywhere in the file; there's no space problems.
13: because the line numbers are dynamic;
14:*They'll slide all the way to 65533.
```

To search for the first occurrence of a string, enter:

```
2,12 Sand<RETURN>
```

The result is:

```
5: those very useful commands that
```

To get the "and" in line 7, modify the search command by entering:

```
<S1><CT>,12 Sand<RETURN>
```

The search then continues from the line after the current line (line 5), since no first line is given. The result is:

```
7: Delete and Insert
```

To Search through several occurrences of a string until the correct string is found, enter:

```
1, ? Sand
```

The result is:

```
5: those very useful commands that
O.K.?_
```

If you press any key except "Y" or <RETURN>, the search continues, so type "N" here:

```
O.K.? N
```

Continue:

```
7 Delete and Insert
O.K.?_
```

Now press press "Y" to terminate the search:

```
O.K.? Y
*_
```

(W)rite

NAME

Write

SYNTAX

[<n>]W

FUNCTION

Write lines from the editing buffer to the output file

COMMENTS

The Write command is used when editing files that are larger than available memory. By executing the Write, lines are written out to the output file and room is made in the input buffer for more lines to be appended from the input file. If W is typed with no <n> parameter, then lines are written until memory is 1/4 full.

If the <n> parameter is given, then <n> lines are written out. Note that lines are written out beginning with the start of the file; subsequent lines in the editing buffer are renumbered beginning with one. A later Append command will append lines to any remaining lines in the editing buffer.

4.4 ERROR MESSAGES

EDLIN error messages occur either when you try to invoke EDLIN or during the actual editing session.

4.4.1 Errors When Invoking EDLIN

Cannot edit .BAK file--rename file

Cause: The user attempted to edit a file with the filename extension .BAK. .BAK files cannot be edited because the extension is reserved for backup copies.

Cure: If the user needs the .BAK file for editing purposes, the user must either RENAME the file with a different extension or COPY the .BAK file but with a different filename extension.

No room in directory for file

Cause: When the user attempted to create a new file, either the file directory was full or the user specified an illegal disk drive or an illegal filename.

Cure: Check the EDLIN invocation command line for illegal filename and illegal disk drive entries. If the command is no longer on the screen and if the user has not yet entered a new command, the EDLIN invocation command can be recovered by pressing the <CT> key.

If the invocation command line contains no illegal entries, run the CHKDSK program for the specified disk drive. If the status report shows the disk directory full, remove the disk and insert and format a new disk. If the CHKDSK status report shows the disk directory is not full, check the EDLIN invocation command for an illegal filename or illegal disk drive designation.

4.4.2 Errors While Editing

Entry Error

Cause: The last command entered contained a syntax error.

Cure: Reenter the command with the correct syntax.

Line too long

Cause: During Replace command mode, the string given as the replacement causes the line to expand beyond the limit of 254 characters. EDLIN aborts the Replace command.

Cure: Divide the long line into two lines, then retry the Replace command.

Disk Full--file write not completed

Cause: The user gave the End command, but the disk did not contain enough free space for the whole file. EDLIN aborts the E command and returns the user to the operating system. Some of the file may have been written to the disk.

Cure: Only a portion (at most) of the file will have been saved. The user should probably delete whatever file was saved and restart the editing session. None of the file not written out will be available after this error. Always be sure that the disk has sufficient free space for the file to be written, before you begin your editing session.

CHAPTER 5

DEBUG

DEBUG is a debugging program used to provide a controlled testing environment for binary and executable object files. Note that EDLIN is used to alter source files; DEBUG is EDLIN's counterpart for binary files. DEBUG eliminates the need to reassemble a program to see if a problem has been fixed by a minor change. It allows you to alter the contents of a file or the contents of a CPU register, and then to immediately reexecute a program to check of the validity of the changes.

All DEBUG commands may be aborted at any time by pressing <CONTROL-C>. <CONTROL-S> suspends the display, so that the user can read it before the output scrolls away. Entering any key other than <CONTROL-C> or <CONTROL-S> restarts the display. All of these commands are consistent with the control character functions available at the MS-DOS command level.

5.1 INVOCATION

To invoke DEBUG, enter:

```
DEBUG [<filespec> [<arglist>] ]
```

For example, if a <filespec> is specified, then the following is a typical invocation:

```
DEBUG FILE.EXE
```

DEBUG then loads FILE.EXE into memory starting at 100 hexadecimal in the lowest available segment. The BX:CX registers are loaded with the number of bytes placed into memory. The DEBUG prompt is a right angle bracket (>).

An <arglist> may be specified if <filespec> is present. These are filename parameters and switches that are to be passed to the program <filespec>. Thus, when <filespec> is loaded into memory, it is loaded as if it had been invoked with the command:

```
<filespec> <arglist>
```

Here, <filespec> is the file to be debugged, and the <arglist> is the rest of the command line that is used when <filespec> is invoked and loaded into memory.

If no <filespec> is specified, then DEBUG is invoked as follows:

```
DEBUG
```

DEBUG then returns with the prompt, signaling that it is ready to accept user commands. Since no filename has been specified, current memory, disk sectors, or disk files can be worked on by invoking later commands.

5.2 COMMANDS

Each DEBUG command consists of a single letter followed by one or more parameters. Additionally, the control character and the special editing functions described in Chapter 2, all apply inside DEBUG.

If a syntax error occurs in a DEBUG command, DEBUG reprints the command line and indicates the error with an up-arrow (^) and the word error.

For example:

```
dcs:100 cs:110
     ^ error
```

All commands and parameters may be entered in either upper or lower case. Any combination of upper and lower case may be used in commands.

The DEBUG commands are summarized in Table 5.1 and are described in detail with examples following the description of command parameters.

Table 5.1 DEBUG Commands

DEBUG Command	Function
C<range> <address>	Compare
D[<range>]	Dump
E<address> [<list>]	Enter
F<range> <list>	Fill
G[=<address> [<address>...]]	Go
H<address> <address>	Hex
I<value>	Input
L[<address> [<drive><record><record>]]	Load
M<range> <address>	Move
N<filespec>	Name
O<value> <byte>	Output
Q	Quit
R[<register-name>]	Register
S<range> <list>	Search
T[=<address>][<value>]	Trace
U[<range>]	Unassemble
W[<address> [<drive><record><record>]]	Write

5.3 PARAMETERS

As the summary above shows, all DEBUG commands accept parameters, except the Quit command. Parameters may be separated by delimiters (spaces or commas), but a delimiter is required only between two consecutive hexadecimal values. Thus, the following commands are equivalent:

```
dcs:100 110
d cs:100 110
d,cs:100,110
```

Also, entries may be made in any combination upper or lower case.

PARAMETER	DEFINITION
<drive>	A one digit hexadecimal value to indicate which drive a file will be loaded from or written to. The valid values are 0-3. These values designate the drives as follows: 0=A:, 1=B:, 2=C:, 3=D:.
<byte>	A two digit hexadecimal value to be placed in or read from an address or register.
<record>	A 1 to 3 digit hexadecimal value used to indicate the logical record number on the disk and the number of disk sectors to be written or loaded. Logical records correspond to sectors. However their numbering differs since they represent the entire disk space.
<value>	A hexadecimal value up to four digits used to specify a port number or the number of times a command should repeat its functions.
<address>	A two part designation consisting of either an alphabetic segment register designation or a four digit segment address plus an offset value. The segment designation or segment address may be omitted, in which case the default segment is used. DS is the default segment for all commands except G, L, T, U, and W, for which the default segment is CS. All numeric values are hexadecimal. For example: CS:0100 04BA:0100 The colon is required between a segment designation (whether numeric or alphabetic) and an offset.

<range> Two <address>s: e.g., <address> <address>; or one <address>, an L, and a <value>: e.g., <address> L <value> where <value> is the number of lines the command should operate on; or simply <address>, and L80 is assumed. The last form can not be used if another hex value follows the <range>, since the hex value would be interpreted as the second <address> of the <range>.

Examples:

```
CS:100 110
CS:100 L 10
CS:100
```

The following is illegal:

```
CS:100 CS:110
       ^ error
```

The limit for <range> is 10000 hex. To specify a <value> of 10000 hex within four digits, enter 0000 (or 0).

<list> A series of <byte> values or of <string>s.line. <list> must be the last parameter on the command line.

Example:

```
fcs:100 42 45 52 54 41
```

<string> Any number of characters enclosed in quote marks. Quote marks may be either single (') or double("). Within <string>s, the opposite set of quote marks may be used freely as literals. If the delimiter quote marks must appear within a <string>, the quote marks must be doubled. For example, the following strings are legal:

```
'This is a "string" is okay.'
'This is a ''string'' is okay.'
```

However, this string is illegal:

```
'This is a 'string' is not.'
```

Similarly, these strings are legal:

```
"This is a 'string' is okay."
"This is a ""string"" is okay."
```

However, this string is illegal:

```
"This is a "string" is not."
```

Note that the double quotations are not necessary in the following strings:

```
"This is a ''string'' is not necessary."
'This is a ""string"" is not necessary.'
```

The ASCII values of the characters in the string are used as a <list> of byte values.

(C)ompare

NAME

Compare

SYNTAX

C<range> <address>

FUNCTION

Compare the portion of memory specified by <range> to a portion of the same size beginning at <address>.

COMMENTS

If the two areas of memory are identical, there is no display and DEBUG returns with the MS-DOS prompt. If there are differences, they are displayed as:

<address1> <byte1> <byte2> <address2>

EXAMPLE

The following commands have the same effect:

```
C100,1FF 300

  or

C100L100 300
```

Each command compares the block of memory from 100 to 1FFH with the block of memory from 300 to 3FFH.

(D)ump

NAME

Dump

SYNTAX

D[<range>]

FUNCTION

Display the contents of the specified region of memory.

COMMENTS

If a range of addresses is specified, the contents of the range are displayed. If the D command is entered without parameters, 128 bytes are displayed at the first address (DS:100) after that displayed by the previous Dump command.

The dump is displayed in two portions: a hexadecimal dump (each byte is shown in hexadecimal value) and an ASCII dump (the bytes are shown in ASCII characters). Nonprinting characters are denoted by a period (.) in the ASCII portion of the display. Each display line shows sixteen bytes with a hyphen between the eighth and ninth bytes. At times, displays are split in this manual to fit them on the page. Each displayed line, except possibly the first, begins on a 16-byte boundary.

If you enter the command:

```
dcs:100 110
```

DEBUG displays:

```
04BA:0100 42 45 52 54 41 ... 4E 44 BERTA T. BORLAND
```

If the following command is entered:

```
D
```

the display is formatted as described above. Each line of the display begins with an address; incremented by 16 from the address on the previous line. Each subsequent D (entered without parameters) displays the bytes immediately following those last displayed.

If the user enters the command:

```
DCS:100 L 20
```

the display is formatted as described above, but 20H bytes are displayed.

If the user enters the command:

```
DCS:100 115
```

the display is formatted as described above, but all the bytes in the range of lines from 100H to 115H in the CS segment are displayed.

(E)nter

NAME

Enter

SYNTAX

E<address>[<list>]

FUNCTION

Enter byte values into memory at the specified <address>.

COMMENTS

If the optional <list> of values is entered, the replacement of byte values occurs automatically. (If an error occurs, no byte values are changed.) If the <address> is entered without the optional <list>, DEBUG displays the address and its contents, then repeats the address on the next line and waits for the user's input. At this point, the Enter command waits for you to perform one of the following actions:

1. Replace a byte value with a value the user types in. The user simply types the value after the current value. If the value typed in is not a legal hexadecimal value or if more than two digits are typed, the illegal or extra character is not echoed.

2. Press the space bar to advance to the next byte. To change the value, simply enter the new value as described in (1.) above. If the user spaces beyond an eight-byte boundary, DEBUG starts a new display line with the address displayed at the beginning.

3. Type a hyphen (-) to return to the preceding byte. If the user decides to change a byte behind the current position, typing the hyphen returns the current position to the previous byte. When the hyphen is typed, a new line is started with the address and its byte value displayed.

4. Press the <RETURN> key to terminate the Enter command. The <RETURN> key may be pressed at any byte position.

(E)nter

EXAMPLE

Assume the following command is entered:

```
ECS:100
```

DEBUG displays:

```
04BA:0100  EB._
```

To change this value to 41, enter "41" as shown:

```
04BA:0100  EB.41_
```

To step through the subsequent bytes, press the space bar to see:

```
04BA:0100  EB.41    10.    00.    BC._
```

To change BC to 42:

```
04BA:0100  EB.41    10.    00.    BC.42_
```

Now, realizing that 10 should be 6F; enter the hyphen as many times as needed to return to byte 0101 (value 10), then replace 10 with 6F:

```
04BA:0100  EB.41    10.    00.    BC.42-
04BA:0102  00.-_
04BA:0101  10.6F_
```

Pressing the <RETURN> key ends the Enter command and returns to the DEBUG command level.

(F)ill

NAME

Fill

SYNTAX

F<range> <list>

FUNCTION

Fill the addresses in the <range> with the values in the <list>.

COMMENTS

If the <range> contains more bytes than the number of values in the <list>, the <list> will be used repeatedly until all bytes in the <range> are filled. If the <list> contains more values than the number of bytes in the <range>, the extra values in the <list> will be ignored. If any of the memory in the <range> is not valid (bad or nonexistent), the error will be propagated into all succeeding locations.

EXAMPLE

Assume the following command is entered:

```
F04BA:100 L 100 42 45 52 54 41
```

DEBUG fills memory locations 04BA:100 through 04BA:1FF with the bytes specified. The five values are repeated until all 100H bytes are filled.

(G)o

NAME

Go

SYNTAX

G[=<address>][<address>...]

FUNCTION

Execute the program currently in memory.

COMMENTS

If the Go command is entered alone, the program executes as if the program had run outside DEBUG.

If =<address> is set, execution begins at the address specified. The equal sign (=) is required, so that DEBUG can distinguish the start =<address> from the breakpoint <address>es.

With the other optional addresses set, execution stops at the first <address> encountered, regardless of that address' position in the list of addresses to halt execution, no matter which branch the program takes. When program execution reaches a breakpoint, the registers, flags, and decoded instruction are displayed for the last instruction executed. (The result is the same as if you had entered the Register command for the breakpoint address.)

Up to ten breakpoints may be set. Breakpoints may be set only at addresses containing the first byte of an 8086 opcode. If more than 10 breakpoints are set, DEBUG returns the BP Error message.

The user stack pointer must be valid and have six bytes available for this command. The G command uses an IRET instruction to cause a jump to the program under test. The user stack pointer is set, and the user Flags, Code Segment register, and Instruction Pointer are pushed on the the user stack. (Thus, if the user stack is not valid or is too small, the operating system may crash.) An interrupt code (0CCH) is placed at the specified breakpoint address(es). When an instruction with the breakpoint code is encountered, all breakpoint addresses are restored to their original instructions. If execution is not halted at

one of the breakpoints, the interrupt codes are not replaced with the original instructions.

EXAMPLE

Assume the following command is entered:

```
GCS:7550
```

The program currently in memory executes up to the address 7550 in the CS segment. Then DEBUG displays registers and flags, after which the Go command is terminated.

After a breakpoint has been encounterd, if you enter the Go command again, then the program executes just as if the user had entered the filename at the MS-DOS command level. The only difference is that program execution begins at the instruction after the breakpoint rather than at the usual start address.

(H)ex

NAME

Hex

SYNTAX

H<value> <value>

FUNCTION

Perform hexadecimal arithmetic on the two parameters.

COMMENTS

First, DEBUG adds the two parameters, then subtracts the second parameter from the first. The results of the arithmetic is displayed on one line; first the sum, then the difference.

EXAMPLE

Assume the following command is entered:

```
H19F 10A
```

DEBUG performs the calculations and then returns the results:

```
02A9   0095
```

(I)nput

NAME

Input

SYNTAX

I<value>

FUNCTION

Input and display one byte from the port specified by <value>.

COMMENTS

A 16-bit port address is allowed.

EXAMPLE

Assume the following command is entered:

```
I2F8
```

Assume also that the byte at the port is 42H. DEBUG inputs the byte and displays the value:

```
42
```

(L)oad

NAME

Load

SYNTAX

L[<address> [<drive> <record> <record>]]

FUNCTION

Load a file into memory.

COMMENTS

Set BX:CX to the number of bytes read. The file must have been named either with the DEBUG invocation command or with the N command. Both the invocation and the N commands format a filename properly in the normal format of a file control block at CS:5C.

If the L command is given without any parameters, DEBUG loads the file into memory beginning at address CS:100 and sets BX:CX to the number of bytes loaded. If the L command is given with an address parameter, loading begins at the memory <address> specified. If L is entered with all parameters, absolute disk sectors are loaded, not a file. The <record>s are taken from the <drive> specified (the drive designation is numeric here--0=A:, 1=B:, 2=C:, etc.); DEBUG begins loading with the first <record> specified, and continues until the number of sectors specified in the second <record> have been loaded.

EXAMPLE

Assume the following commands are entered:

```
A:DEBUG
>NFILE.COM
```

Now, to load FILE.COM, enter:

```
L
```

DEBUG loads the file and returns the DEBUG prompt. Assume you want to load only portions of a file or certain records from a disk. To do this, enter:

```
L04ba:100 2 0F 6D
```

DEBUG then loads 109 (6D hex) records beginning with logical record number 15 into memory

beginning at address 04BA:0100. When the records have been loaded, DEBUG simply returns the its prompt.

If the file has a .EXE extension, then it is relocated to the load address specified in the header of the .EXE file: the <address> parameter is always ignored for .EXE files. Note that the header itself is stripped off the .EXE file before it is loaded into memory. Thus the size of a .EXE file on disk will differ from its size in memory.

If the file named by the Name command or specified on invocation is a .HEX file, then entering the L command with no parameters causes loading of the file beginning at the address specified in the .HEX file. If the L command includes the option <address>, DEBUG adds the <address> specified in the L command to the address found in the .HEX file to determine the start address for loading the file.

NAME

Move

SYNTAX

M<range> <address>

FUNCTION

Move the block of memory specified by <range> to the location beginning at the <address> specified.

COMMENTS

Overlapping moves (moves where part of the block overlaps some of the current addresses) are always performed without loss of data. Addresses that could be overwritten are moved first. The sequence for moves from higher addresses to lower addresses is to move the data beginning at the block's lowest address and working towards the highest. The sequence for moves from lower addresses to higher addresses is to move the data beginning at the block's highest address and working towards the lowest.

Note that if the addresses in the block being moved will not have new data written to them, the data there before the move will remain; that is, the M command really copies the data from one area into another, in the sequence described, and writes over the new addresses. This is why the sequence of the move is important.

EXAMPLE

Assume you enter:

```
MCS:100 110 CS:500
```

DEBUG first moves address CS:110 to address CS:510, then CS:10F to CS:50F, and so on until CS:100 is moved to CS:500. You should enter the D command, using the <address> entered for the M command, to review the results of the move.

(N)ame

NAME

Name

SYNTAX

N<filename>[<filename>...]

FUNCTION

Set filenames

COMMENTS

The Name command performs two distinct functions, both having to do with filenames. First, Name is used to assign a filename for a later Load or Write command. Thus, if you invoke DEBUG without naming any file to be debugged, then the N<filename> command must be given before a file can be Loaded. Second, Name is used to assign filename parameters to the file being debugged. In this case, Name accepts a list of parameters that are used by the file being debugged.

These functions overlap. Consider the following set of DEBUG commands:

```
>NFILE1.EXE
>L
>G
```

Because of the two-pronged effect of the Name command, the following happens:

1. (N)ame assigns the filename FILE1.EXE to the filename to be used in any later Load or Write commands.

2. (N)ame also assigns the filename FILE.EXE to the first filename parameter to be used by any program that is later debugged.

3. (L)oad loads FILE.EXE into memory.

4. (G)o causes FILE.EXE to be executed with FILE.EXE as the single filename parameter (that is, FILE.EXE is executed as if FILE FILE.EXE had been typed at the command level.

A more useful chain of commands might go like this:

```
>NFILE1.EXE
>L
>NFILE2.DAT FILE3.DAT
>G
```

Here, Name sets FILE1.EXE as the filename for the subsequent Load command. The Load command loads FILE1.EXE into memory, and then the Name command is used again, this time to specify the parameters to be used by FILE1.EXE. Finally, when the Go command is executed, FILE1.EXE is executed as if FILE1 FILE2.DAT FILE3.DAT had been typed at the MS-DOS command level. Note that if a Write command were executed at this point, then FILE1.EXE--the file being debugged--would be saved with the name FILE2.DAT! To avoid such undesired results, you should always execute a Name command before either a Load or a Write.

There are four distinct regions of memory that can be affected by the Name command:

```
CS:5C  FCB for file 1
CS:6C  FCB for file 2
CS:80  Count of characters
CS:81  All characters entered
```

A File Control Block (FCB) for the first filename parameter given to the Name command is set-up at CS:5C. If a second filename parameter is given, then an FCB is setup for it beginning at CS:6C. The number of characters typed in the Name command (exclusive of the first character, "N") is given at location CS:80. The actual stream of characters given by the Name command (again, exclusive of the letter "N") begins at CS:81. Note that this stream of characters may contain switches and and delimiters that would be legal in any command typed at the MS-DOS command level.

EXAMPLE

A typical use of the Name command would be:

```
DEBUG PROG.COM
-NPARAM1 PARAM2/C
-G
-
```

(N)ame

In this case, the Go command executes the file in memory as if the following command line had been entered:

```
PROG PARAM1 PARAM2/C
```

Testing and debugging therefore reflect a normal runtime environment for PROG.COM.

(O)utput

NAME

Output

SYNTAX

O<value> <byte>

FUNCTION

Send the <byte> specified to the output port specified by <value>.

COMMENTS

A 16-bit port address is allowed.

EXAMPLE

Enter:

```
O2F8 4F
```

DEBUG outputs the byte value 4F to output port 2F8.

(Q)uit

NAME

Quit

SYNTAX

Q

FUNCTION

Terminate the debugger.

COMMENTS

The Q command takes no parameters and exits DEBUG without saving the file currently being operated on. You are returned to the MS-DOS commands level.

EXAMPLE

To end the debugging session, enter:

```
Q<RETURN>
```

DEBUG is terminated, and control returns to the MS-DOS command level.

(R)egister

NAME

Register

SYNTAX

R[<register-name>]

FUNCTION

Display the contents of one or more CPU registers.

COMMENTS

If no <register-name> is entered, the R command dumps the register save area and displays the contents of all registers and flags.

If a register name is entered, the 16-bit value of that register is displayed in hexadecimal, and then a colon appears as a prompt. The user then either enters a <value> to change the register, or simply presses the <RETURN> key if no change is wanted.

The only valid <register-name>s are:

AX	BP	SS	
BX	SI	CS	
CX	DI	IP	(IP and PC both refer
DX	DS	PC	to the instruction
SP	ES	F	pointer.)

Any other entry for <register-name> results in a BR Error message.

If F is entered as the <register-name>, DEBUG displays each flag with a two character alphabetic code. To alter any flag, enter the opposite two letter code. The flags are either set or clear.

(R)egister

The flags with their codes for set and clear are listed below:

FLAG NAME	SET	CLEAR
Overflow	OV	NV
Direction	DN Decrement	UP Increment
Interrupt	EI Enabled	DI Disabled
Sign	NG Negative	PL Plus
Zero	ZR	NZ
Auxiliary Carry	AC	NA
Parity	PE Even	PO Odd
Carry	CY	NC

Whenever the user enters the command RF, the flags are displayed in the order shown above in a row at the beginning of a line. At the end of the list of flags, DEBUG displays a hyphen (-). You may enter new flag values as alphabetic pairs. The new flag values can be entered in any order. You are not required to leave spaces between the flag entries. To exit the R command, press the <RETURN> key. Flags for which new values were not entered remain unchanged.

If more than one value is entered for a flag, DEBUG returns a DF Error message. If the you enter a flag code other than those shown above, DEBUG returns a BF Error message. In both cases, the flags up to the error in the list are changed; flags at and after the error are not.

At start up, the segment registers are set to the bottom of free memory, the Instruction Pointer is set to 0100H, all flags are cleared, and the remaining registers are set to zero.

EXAMPLE

Enter:

(R)egister

```
R
```

DEBUG displays all registers, flags, and the decoded instruction for the current location. If the location is CS:11A, then DEBUG might display:

```
AX=0E00 BX=00FF CX=0007 DX=01FF SP=039D BP=0000
SI=005C DI=0000 DS=04BA ES=04BA SS=04BA CS=04BA
IP=011A  NV UP DI NG NZ AC PE NC
04BA:011A  CD21          INT     21
```

If you enter:

```
RF
```

DEBUG displays the flags:

```
NV UP DI NG NZ AC PE NC - _
```

Now enter any valid flag designation, in any order, with or without spaces.

For example:

```
NV UP DI NG NZ AC PE NC - PLEICY<RETURN>
```

DEBUG responds only with the DEBUG prompt. To see the changes, enter either the R or RF command:

```
RF
NV UP EI PL NZ AC PE CY - _
```

Press <RETURN> to leave the flags this way, or to enter different flag values.

(S)earch

NAME

Search

SYNTAX

S<range> <list>

FUNCTION

Search the range specified for the <list> of bytes specified.

COMMENTS

The <list> may contain one or more bytes, each separated by a space or comma. If the <list> contains more than one byte, only the first address of the byte string is returned. If the <list> contains only one byte, all addresses of the byte in the <range> are displayed.

EXAMPLE

If you enter:

```
SCS:100 110 41
```

DEBUG might return the response:

```
04BA:0104
04BA:010D
>_
```

(T)race

NAME

Trace

SYNTAX

T[=<address>][<value>]

FUNCTION

Execute one instruction and display the contents of all registers, flags, and the decoded instruction.

COMMENTS

If the optional =<address> is entered, tracing occurs at the =<address> specified. The optional <value> causes DEBUG to execute and trace the number of steps specified by <value>.

The T command uses the hardware trace mode of the 8086 or 8088 microprocessor. Consequently, the user may also trace instructions stored in ROM.

EXAMPLE

Enter:

```
T
```

DEBUG returns a display of the registers, flags, and decoded instruction for that one instruction. Assume that the current position is 04BA:011A; then DEBUG might return the display:

```
AX=0E00 BX=00FF CX=0007 DX=01FF SP=039D BP=0000
SI=005C DI=0000 DS=04BA ES=04BA SS=04BA CS=04BA
IP=011A  NV UP DI NG NZ AC PE NC
04BA:011A  CD21          INT     21
```

Now enter:

```
T=011A 10
```

DEBUG executes sixteen (10 hex) instructions beginning at 011A in the current segment and then displays all registers and flags for each instruction as it is executed. The display scrolls away until the last instruction is executed. Then the display stops, and you can see the register and flag values for the last few instructions performed. Remember that

(T)race

<CONTROL-S> suspends the display at any point, so that you can study the registers and flags for any instruction.

NAME

Unassemble

SYNTAX

U[<range>]

FUNCTION

Disassemble bytes and display the source statements that correspond to them, along with addresses and byte values.

COMMENTS

The display of disassembled code looks like a listing for an assembled file. If you enter the U command without parameters, 20 hexadecimal bytes are disassembled at the first address after that displayed by the previous Unassemble command. If you enter the U command with the <range> parameter, then DEBUG disassembles all bytes in the range. If the <range> is given as an <address only, then 20H bytes are disassembled, not 80H.

EXAMPLE

Enter:

```
U04BA:100 L10
```

DEBUG disassembles 16 bytes beginning at address 04BA:0100:

```
04BA:0100  206472      AND   [SI+72],AH
04BA:0103  69          DB    69
04BA:0104  7665        JBE   016B
04BA:0106  207370      AND   [BP+DI+70],DH
04BA:0109  65          DB    65
04BA:010A  63          DB    63
04BA:010B  69          DB    69
04BA:010C  66          DB    66
04BA:010D  69          DB    69
04BA:010E  63          DB    63
04BA:010F  61          DB    61
```

If you enter:

```
u04ba:0100 0108
```

The display shows:

```
04BA:0100  206472      AND   [SI+72],AH
04BA:0103  69          DB    69
04BA:0104  7665        JBE   016B
04BA:0106  207370      AND   [BP+DI+70],DH
```

If the bytes in some addresses are altered, the disassembler alters the instruction statements. The U command can be entered for the changed locations, the new instructions viewed, and the disassembled code used to edit the source file.

(W)rite

NAME

Write

SYNTAX

W[<address>[<drive> <record> <record>]]

FUNCTION

Write the file being debugged to a disk file.

COMMENTS

If only the W appears, BX:CX must already be set to the number of bytes to be written; the file is written beginning from CS:100. If the W command is given with just an address, then the file is written beginning at that address. If a G or T command was used, BX:CX must be reset before using the Write command without parameters. (Note that if a file is loaded and modified, the name, length, and starting address are all set correctly to save the modified file as long as the length has not changed.)

The file must have been named either with the DEBUG invocation command or with the N command (see Name above). Both the invocation and the N commands format a file name properly in the normal format of a file control block at CS:5C.

If the W command is given with parameters, the write begins from the memory address specified; the file is written to the <drive> specified (the drive designation is numeric here--0=A:, 1=B:, 2=C:, etc.); DEBUG writes the file beginning at the logical record number specified by the first <record>; and continues until the number of sectors specified in the second <record> have been written.

WARNING

Writing to absolute sectors is EXTREMELY dangerous because the process bypasses the file handler.

(W)rite

EXAMPLE

Enter:

```
W
```

DEBUG writes out the file to disk then displays the DEBUG prompt:

```
W
>_
```

Another example:

```
WCS:100 1 37 2B
```

DEBUG writes out the contents of memory, beginning with the address CS:100 to the disk in drive B:. The data written out starts in disk logical record number 37H and consists of 2BH records. When the write is complete, DEBUG displays the prompt:

```
WCS:100 1 37 2B
>_
```

5.4 ERROR MESSAGES

During the DEBUG session, you may receive any of the following error messages. Each error terminates the DEBUG command with which it is associated, but does not terminate DEBUG itself.

ERROR CODE	DEFINITION
BF	Bad Flag The user attempted to alter a flag, but the characters entered were not one of the acceptable pairs of flag values. See the Register command for the list of acceptable flag entries.
BP	Too many Breakpoints The user specified more than ten breakpoints as parameters to the G command. Reenter the Go command with ten or fewer breakpoints.
BR	Bad Register The user entered the R command with an invalid register name. See the Register command for the list of valid register names.
DF	Double Flag The user entered a two values for one flag. The user may specify a flag value only once per RF command.

CHAPTER 6

FILCOM

The FILCOM File Comparison Utility compares the contents of two files. The differences between the two files are output to a third file. The files being compared may be either source files (files containing source statements of a programming language) or binary files (files output by the MACRO-86 assembler, the MS-LINK Linker Utility, or by one of the Microsoft high-level language compilers).

Limitations on Source Comparisons

FILCOM uses all available memory as buffer space to hold the source files. If the source files are larger than available memory, FILCOM comparisons what it is able to load into the buffer space. If no matches are found within the portions of the files in the buffer space, FILCOM outputs only the message:

FILES ARE DIFFERENT

For binary files larger than available memory, FILCOM compares both files completely, overlaying the portion in memory with the next portion from disk. All differences are output the same as for binary comparisons of files that fit completely in memory.

6.1 INVOCATION

FILCOM can be invoked in one of two ways.

Method 1:

Enter:

```
FILCOM
```

FILCOM responds with the first prompt and then waits:

```
Source 1 Filename [.ASM]:
```

Method 2:

Enter:

```
FILCOM <source1>,[<source2>],[<list>][/<switch>...]
```

FILCOM and the filenames must be separated by commas. The slash mark is the only delimiter allowed between a filename and a switch letter. Switches may be placed after any of the entries in the invocation command line, but before the comma.

If you want to select the default for Source 2 but not for List, enter two consecutive commas between Source 1 and List entries.

For example:

```
FILCOM ALPHA,,GAMMA
```

When method 2 is used, FILCOM responds with a banner but no prompts, and performs the comparison. Method 2 permits FILCOM commands to be used in a batch file under MS-DOS, as well as permitting you to enter all commands on one line at one time. When FILCOM is finished, the operating system prompt reappears.

6.2 COMMANDS

Commands to FILCOM consist of responses to three prompts for file specifications, plus optional switches. The file specifications may be entered one at a time as the prompts appear, or all at once as part of the FILCOM invocation command (method 2).

6.2.1 File Specifications

All file specifications take the form:

```
d:filename.ext
```

where: d: is the letter of a disk drive. If the drive designation is omitted, FILCOM defaults to the operating system's (current) default drive.

filename is a 1-8 character name of the file.

.ext is a 1-3 character extension to the filename. See Section 5.2.3, Defaults and Shortcuts, for a list of the default filename extensions used under FILCOM and their effects.

6.2.2 Prompts

If invocation method 2 is used, FILCOM displays no prompts; it simply performs the comparison and exits to the operating system.

If invocation method 1 is used (or else method 2 with an illegal filename or the name of a nonexistent file for the first source file), FILCOM displays the first prompt:

```
Source 1 Filename [.ASM]:_
```

Enter the name of one of the files you want compared. If the filename extension for this file is .ASM, the extension may be omitted from the entry. Otherwise, the extension must be included.

When a legal response has been entered, FILCOM responds with the second prompt:

```
Source 2 Filename [source1.BAK]:_
```

Enter the name of the file you want compared to Source 1. FILCOM defaults to the backup file for the file named for the first prompt. If the response to prompt 1 is TEST (meaning TEST.ASM), FILCOM will display as default for Source 2 the filename TEST.BAK. If you want to compare the Source 1 file with its backup file, simply press <RETURN>. Otherwise, enter a filename. Likewise, if the Source 2 file has a filename extension of .BAK, the extension may be omitted. Otherwise, the extension must be entered, too.

When a legal response to the second prompt has been entered, FILCOM responds with the third prompt:

```
List Filename [source1.DIF]:_
```

Enter the name of the file to receive the list of differences. FILCOM defaults to the name given for Source 1 with a default filename extension of .DIF. Again, if the response to prompt 1 was TEST (meaning TEST.ASM), FILCOM displays TEST.DIF as the default List filename. If this default filename is acceptable to you for the List file, simply press the carriage return key. Otherwise, enter the filename. Likewise, if the filename extension .DIF is acceptable to you, the extension may be omitted, even if you do specify a filename. If .DIF is an unacceptable filename extension, enter an extension along with the filename.

When FILCOM is finished comparing the two source files and has output the differences to the List file, the operating system prompt reappears.

6.2.3 Defaults And Shortcuts

FILCOM recognizes the following default extensions:

Prompt	Extension	Effect
Source 1	.ASM	Default Source 1 filename extension. May be overridden.
	.OBJ .EXE .COM	Causes default to binary comparison
Source 2	.BAK	Default Source 2 Filename extension. May be overridden.
List	.DIF	Default List Filename extension. May be overridden.

Shortcuts

Two shortcuts for entering commands are supported. Both shortcuts use default responses for any prompts to which a response is not entered.

Carriage return key

The Source 1 Filename [.ASM] prompt requires at least a filename response.

The Source 2 Filename [sourcel.BAK] and List Filename [sourcel.DIF] prompts show a default entry; the filename entered for Source 1 and a default filename extension. To select the default entry, simply press the <RETURN> key.

Example:

```
Source 1 Filename [.ASM]: TEST
Source 2 Filename [TEST.BAK]: <RETURN>
List Filename [TEST.DIF]: <RETURN>
```

These responses cause FILCOM to compare TEST.ASM with TEST.BAK and to output any differences in the file TEST.DIF.

<RETURN> only may be entered for either of the prompts, regardless of what you plan to enter for the other. For example, the <RETURN> may be used to select the default for Source 2, yet allows a nondefault entry for List.

Example:

```
Source 1 Filename [.ASM]: TEST
Source 2 Filename [TEST.BAK]: <RETURN>
List Filename [TEST.DIF]: PAST.PRN
```

These responses cause FILCOM to compare TEST.ASM with TEST.BAK and to output any differences in the file PAST.PRN (default for Source 2 was selected, but not for List.)

Semicolon (;)

The semicolon character (;) also selects the default responses to the Source 2 and List prompts. If the semicolon is entered following the Source 2 Filename prompt, the List Filename prompt will not appear. That is, the semicolon selects the default response for all remaining prompts. Unlike the carriage return key, once you enter semicolon, comparing begins, and you have no chance to enter another response for that comparison. Indeed, you may think of the semicolon as a message to FILCOM that you want to use all default responses only.

This is especially useful when using invocation method 2:

Example:

```
FILCOM TEST;
```

This entry causes FILCOM to display its banner and then perform the desired comparison. FILCOM compares TEST.ASM with TEST.BAK and outputs the differences in the file TEST.DIF (the same as the example under "Carriage Return Key" above).

Now, consider this sample invocation:

```
FILCOM
Source 1 Filename [.ASM]: TEST;
```

This set of commands and responses produces the same result as the two previous examples. Note that you have no chance to enter alternatives to the defaults for Source 2 or List when you use the semicolon.

6.2.4 Switches

FILCOM supports five switches. Switches are single letters appended to the (method 2) invocation command line or to any of the prompt responses to control the file comparison. A switch must always be preceded by a slash.

FILCOM switches are one of two types: source comparison or binary comparison.

Source Comparison Switches

/A Force a source comparison of files with filename extensions .OBJ, .EXE, and .COM. FILCOM defaults to binary comparison on files with these filename extensions. Files with any other filename extensions default to source comparison. Therefore, /A is not required for files that do not have one of these three filename extensions.

/C Include comments in comparison. A comment starts with a semicolon (;), and ends with an end-of-line character. By default, comments are not included in comparisons. Thus, only functional changes in source files are detected by FILCOM. This means that comments in two files, even if different, are ignored when searching for consecutive lines that match (see the /<n> switch below for an explanation of "match").

/<n> <n> is a number from 1 through 9. Default is 3. <n> specifies how many consecutive lines in the two files must be the same before FILCOM considers that the two files match at that point. (Refer to examples 1 and 2 below for a demonstration of the effects of the /<n> switch).

When FILCOM finds <n> lines that match, it outputs the lines that are different since the last <n> lines that matched, plus the first line of the current <n> lines that match. The first match line should help locate where differences occurred.

/S Include spaces and tabs in comparisons. By default, spaces and tabs are <u>not</u> included in comparisons. Thus, only functional changes in source files are detected by FILCOM. This means that spaces and tabs in the two files, even if the same, are ignored and are not used to find matches.

Binary Comparison Switch

/B Force binary comparison of files that default to source comparison (files without the filename extensions .OBJ, .EXE, or .COM). Instead of a source comparison of lines, FILCOM compares the two files byte-by-byte. For differences, FILCOM outputs the offset location into the files and the differing bytes in hexadecimal. (Refer to example 3 for a demonstration.)

6.3 EXAMPLES

Example 1

Assume these two ASCII files are on disk:

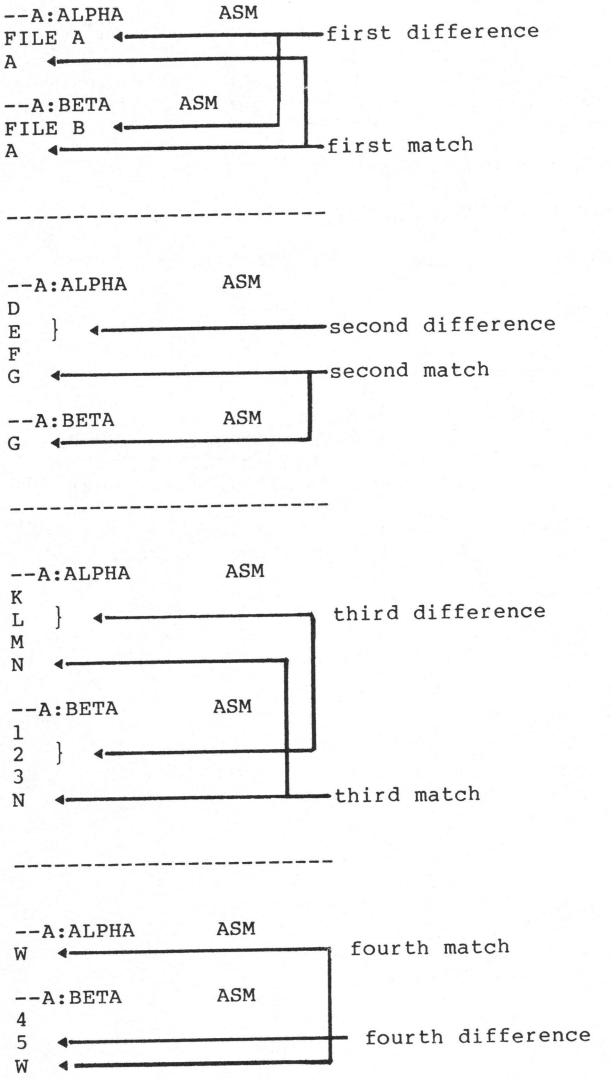
ALPHA.ASM	BETA.ASM
FILE A	FILE B
A	A
B	B
C	C
D	G
E	H
F	I
G	J
H	1
I	2
M	P
N	Q
O	R
P	S
Q	T
R	U
S	V
T	4
U	5
V	W
W	X
X	Y
Y	Z
Z	

To compare the two files and output the differences on the terminal screen, enter the following (method 2) command line:

```
FILCOM ALPHA,BETA.ASM,CON
```

FILCOM is directed to compare ALPHA.ASM with BETA.ASM and output the differences on the terminal screen. All other defaults remain intact (do not use tabs, spaces, or comments for matches, and conduct a source comparison).

The output appears as follows on the terminal screen:


--A:ALPHA ASM
FILE A
A
first difference
--A:BETA ASM
FILE B
A
first match

--A:ALPHA ASM
D
E
F
G
second difference
second match
--A:BETA ASM
G

--A:ALPHA ASM
K
L
M
N
third difference
--A:BETA ASM
1
2
3
N
third match

--A:ALPHA ASM
W
fourth match
--A:BETA ASM
4
5
W
fourth difference

Example 2

Using the same two source files, output the differences on the line printer. Also, require that four successive lines must be the same to constitute a match.

Using invoke method 2 again, enter:

```
FILCOM ALPHA,BETA.ASM,PRN/4
```

The following output should appear on the line printer:

```
--A:ALPHA          ASM
FILE A
A
B   }
C
D
E
F
G

--A:BETA           ASM
FILE B
A
B   }
C
G
```

These lines are listed as different because the /4 switch specifies that 4 consecutive lines must be found identical in the two files before they are considered a match.

```
-------------------------

--A:ALPHA          ASM
K
L
M
N

--A:BETA           ASM
1
2
3
N

-------------------------

--A:ALPHA          ASM
W

--A:BETA           ASM
4
5
W
```

Example 3

Using the same two source files again, force a binary comparison, then output the differences on the terminal screen.

Using invoke method 1,enter:

```
FILCOM
```

FILCOM responds:

```
Source 1 Filename [.ASM]:
```

Entries and responses should appear as follows:

```
Source 1 Filename [.ASM]:  ALPHA/B
Source 2 Filename [ALPHA.BAK]:  BETA.ASM
List Filename [ALPHA.DIF]:  CON
```

The /B switch at the end of the Source 1 line forces binary comparison. This switch, and the others, may be entered at the end of any of the response entries. The switches may be, but need not be, entered on the same response line.

The screen display should appear as follows:

```
ADDRESS ALPHA ASM       BETA ASM
 00006   41      42
 00012   44      47
 00015   45      48
 00018   46      49
 0001B   47      4A
 0001E   48      31
 00021   49      32
 00024   4A      33
 00027   4B      4E
 0002A   4C      4F
 0002D   4D      50
 00030   4E      51
 00033   4F      52
 00036   50      53
 00039   51      54
 0003C   52      55
 0003F   53      56
 00042   54      34
 00045   55      35
 00048   56      57
 0004B   57      58
 0004E   58      59
 00051   59      5A
```

APPENDIX A

Instructions for Single Disk Drive Users

For single disk drive users the commands are exactly the same syntax as for two drive users. The difference lies in your perception of the "arrangement" of the drives.

You must think of his system as having two disk drives: drive A: and drive B:. However, instead of A: and B: designating physical disk drive mechanisms, the A: and B: designate diskettes. Therefore, when the user specifies drive B: while operating on drive A: (the prompt is A:), MS-DOS prompts the user to "switch drives" by swapping diskettes.

The prompts are:

> Insert diskette for drive A: and strike any key when ready
>
> Insert diskette for drive B: and strike any key when ready

These procedures apply to any MS-DOS COMMAND commands (both internal and external) that can request or direct a different drive as a part of its syntax. These commands include:

```
CHKDSK [d:]
COPY <filespec>[filespec]
DEL <filespec> [filespec...]
DIR [d:][filename]
FORMAT d:[/S]
RENAME <filespec> <filename>
TYPE <filespec>
```

Also, if any of these commands are used in a BATCH file and call for a different drive, the single disk drive procedures apply. Execution is halted and the appropriate prompt is displayed.

EXAMPLE

The following example may serve as an illustration for all of the commands listed above:

```
A:COPY COMMAND.COM B:  Insert diskette for drive
B: and depress space bar when ready
    1 File(s) copied

Insert diskette for drive A: and depress space bar
when ready
A:_
```

APPENDIX B

MS-DOS File Control Block Definition

The MS-DOS File Control Block (FCB) is defined as follows:

byte 0	Drive Code. Zero specifies the default drive, 1=drive A, 2=drive B, etc.
bytes 1-8	File name. If the file is less than 8 characters, the name must be left justified with trailing blanks.
bytes 9-11	Extension to file name. If less than 3 characters, must be left justified with trailing blanks. May also be all blanks.
bytes 12-13	Current block (extent). This word (low byte first) specifies the current block of 128 records, relative to the start of the file, in which sequential disk reads and writes occur. If zero, then the first block of the file is being accessed; if one, then the second etc. Combined with the current record field(byte 32) a particular logical record is identified.
bytes 14-15	Size of the record the user wishes to work with. This word may be filled immediately after an OPEN of the file if the default logical record size(128 bytes) is not desired. The Open and Create functions set this field to 128; it is also changed to 128 if a read or write is attempted with the field set to zero.
bytes 16-19	File size. This is the current size, in bytes, of the file. It may read by user programs but must not be written by them.
bytes 20-21	Date. This is normally the date of the last write to the file. It is set by all disk write operations and Create to today's date. It is set by Open to the date recorded in the

disk directory for the file. User programs may modify this field after writing to a file but before closing it to change the date recorded in the disk directory.

The format of this 16-bit field is as follows: bits 0-4, day of month; bits 5-8, month of year; bits 9-15, year minus 1980. All zero means no date.

bytes 22-23 — Time. Similar to Date, above. The format is bits 0-4, seconds/2; bits 5-10, minutes; bits 11-15, hours.

bytes 24-31 — Reserved for MS-DOS.

byte 32 — Current record. Identifies the record within the current block of 128 records that will be accessed with a sequential read or write function. See Current Block,bytes 12-13.

bytes 33-36 — Random Record. This field must only be set if the file is to be accessed with a random read or write function. If the record size is greater than or equal to 64 bytes, only the first 3 bytes are used, as a 24-bit number representing the position in the file of a record. If the record size if less than 64 bytes, all 4 bytes are used as 32-bit number of the same purpose. This field is thus large enough to address any byte in a file of the maximum size, 2^30 bytes.

THE EXTENDED FCB

The extended FCB is a special format used to search for files in the disk directory with special attributes. It consists of 7 bytes in front of a normal FCB, formatted as follows:

FCB-7 — Flag. FF hex is placed here to signal an extended FCB.

FCB-6 - FCB-2 — Zero field

FCB-1 — Attribute byte. If bit 1 = 1, hidden files will be included in directory searches. If bit 2 = 1, system files will be included in directory searches.

Any reference in the description of MS-DOS function calls to an FCB, whether opened or unopened, may use either a normal FCB or an extended FCB. A normal FCB has the same effect as an extended FCB with the attribute byte set to zero.

APPENDIX C

MS-DOS INTERRUPTS AND FUNCTION CALLS

C.1 INTERRUPTS

MS-DOS Reserves interrupt types 20 to 3F hex for its use. This means absolute locations 80 to FF hex are the transfer address storage locations reserved by the DOS. The defined interrupts are as follows with all values in hex:

20 Program terminate. This is the normal way to exit a program. This vector transfers to the logic in the DOS for restoration of <CONTROL-C> exit addresses to the values they had on entry to the program. All file buffers are flushed to disk. All files that have changed in length should have been closed (see function call 10 hex) prior to issuing this interrupt. If the changed file was not closed its length will not be recorded correctly in the directory. When this interrupt is executed, CS MUST point to the 100H parameter area.

21 Function request. See section II FUNCTION REQUESTS.

22 Terminate address. The address represented by this interrupt(88-8B hex) is the the address to which control will transfer when the program terminates. This address is copied into low memory of the segment the program is loaded into at the time this segment is created. If a program wishes to execute a second program it must set the terminate address prior to creation of the segment the program will be loaded into. Otherwise once the second program executes its termination would cause transfer to its host's termination address.

23 <CONTROL-C> exit address. If the user types <CONTROL-C> during keyboard input or video output, "^C" will be printed on the console and an interrupt type 23 hex will be executed. If the <CONTROL-C>

routine preserves all registers, it may end with a a return-from-interrupt instruction (IRET) to continue program execution. If functions 9 or 10 (buffered output and input), were being executed, then I/O will continue from the start of the line. When the interrupt occurs, all registers are set to the value they had when the original call to MS-DOS was made. There are no restrictions on what the <CONTROL-C> handler is allowed to do, including MS-DOS function calls, so long as the registers are unchanged if IRET is used.

If the program creates a new segment, loads in a second program which itself changes the <CONTROL-C> address, the termination of the second program and return to the first will cause the <CONTROL-C> address to be restored to the value it had before execution of the second program.

24 Fatal error abort vector. When a fatal error occurs within MS-DOS, control will be transferred with an INT 24H. On entry to the error handler, AH will have its bit 7=0 if the error was a hard disk error (probably the most common occurrence), bit 7=1 if not. If it is a hard disk error, bits 0-2 include the following:

bit 0			0 if read, 1 if write
bit 2	1		AFFECTED DISK AREA
0	0		Reserved area
0	1		File allocation table
1	0		Directory
1	1		Data area

AL, CX, DX, and DS:BX will be setup to perform a retry of the transfer with INT 25H or INT 26H (below). DI will have a 16-bit error code returned by the hardware.

The values returned are:

0	write protect
2	disk not ready
4	data error
6	Seek error
8	Sector not found
A	Write fault
C	General disk failure

The registers will be set up for a BIOS disk call and the returned code will be in the lower half of the DI register with the upper half undefined. The user stack will look as follows from top to bottom:

```
IP      Registers such that if an IRET is executed
CS      the DOS will respond according to (AL)
FLAGS   as follows:

        (AL)=0      ignore the error
            =1      retry the operation
                    (IF THIS OPTION USED STACK DS,
                     BX,CX AND DX MUST NOT BE MODIFIED!)
            =2 abort the program


AX      USER REGISTERS AT TIME OF REQUEST
BX
CX
DX
SI
DI
BP
DS
ES
IP      The interrupt from the user to the DOS
CS
FLAGS
```

Currently, the only error possible when AH bit 7=1 is a bad memory image of the file allocation table.

25 Absolute disk read. This transfers control directly to the DOS BIOS. Upon return, the original flags are still on the stack (put there by the INT instruction). This is necessary because return information is passed back in the flags. Be sure to to pop the stack to prevent uncontrolled growth. For this entry point "records" and "sectors" are the same size. The request is as follows:

```
(AL)     Drive number (0=A, 1=B, etc.)
(CX)     Number of sectors to read
(DX)     Beginning logical record number
(DS:BX)  Transfer address
```

The number of records specified are transferred between the given drive and the transfer address. "Logical record numbers" are obtained by numbering each sector sequentially starting from zero and continuing across track boundarys. For example logical record number 0 is track 0 sector 1, whereas logical record number 12 hex is track 2 sector 3.

All registers but the segment registers are destroyed by this call. If the transfer was successful the carry flag (CF) will be zero. If the transfer was not successful CF=1 and (AL) will indicate the error as follows:

Return	Description
0	Attempt to write on write protected disk
2	Disk not ready
4	Data error
6	Seek error
8	Sector not found
C	General disk failure
A	Write fault

26 Absolute disk write. This vector is the counterpart to interrupt 25 above. Except for the fact that this is a write the description above applies.

27 Terminate but stay resident. This vector is used by programs which are to remain resident when COMMAND regains control. Such a program is loaded as an executing COM file by COMMAND. After it has initialized itself, it must set DX to its last address plus one in the segment it is executing in, then execute an interrupt 27H. COMMAND will then treat the program as an extension of MS-DOS, and the program will not be overlaid when other programs are executed.

C.2 FUNCTION REQUESTS

The user requests a function by placing a function number in the AH register, supplying additional information in other registers as necessary for the specific function then executing an interrupt type 21 hex. When MS-DOS takes control it switches to an internal stack. User registers except AX are preserved unless information is passed back to the requester as indicated in the specific requests. The user stack needs to be sufficient to accommodate the interrupt system. It is recommended that it be 80 hex in addition to the user needs. There is an additional mechanism provided for programs that conforms to CP/M calling conventions. The function number is placed in the CL register, other registers are set as normal according to the function specification, and an intrasegment call is made to location 5 in the current code segment. This method is only available to functions which do not pass a parameter in AL and whose numbers are equal to or less than 36. Register AX is always destroyed if this mechanism is used, otherwise it is the same as normal function requests. The functions are as follows with all values in hex:

0 Program terminate. The terminate and <CONTROL-C> exit addresses are restored to the values they had on entry to the terminating program. All file

buffers are flushed, but files which have been changed in length but not closed will not be recorded properly in the disk directory. Control transfers to the terminate address.

1 Keyboard input. Waits for a character to be typed at the keyboard, then echos the character to the video device and returns it in AL. The character is checked for a <CONTROL-C>. If this key is detected an interrupt 23 hex will be executed.

2 Video output. The character in DL is output to the video device. If a <CONTROL-C> is detected after the output an interrupt 23 hex will be executed.

3 Auxiliary input. Waits for a character from the auxiliary input device, then returns that character in AL.

4 Auxiliary output. The character in DL is output to the auxiliary device.

5 Printer output. The character in DL is output to the printer.

6 Direct console I/O. If DL is FF hex, the AL returns With keyboard input character if one is ready, otherwise 00. If DL is not FF hex, then DL is assumed to have a valid character which is output to the video device.

7 Direct console input. Waits for a character to be typed at the keyboard, then returns the character in AL. As with function 6, no checks are made on the character.

8 Console input without echo. This function is identical to function 1, except the key is not echoed.

9 Print string. On entry, DS:DX must point to a character string in memory terminated by a "$" (24 hex). Each character in the string will be output to the video device in the same form as function 2.

A Buffered keyboard input. On entry, DS:DX point to an input buffer. The first byte must not be zero and specifies the number of characters the buffer can hold. Characters are read from the keyboard and placed in the buffer beginning at the third byte. Reading the keyboard and filling the buffer continues until <RETURN> is typed. If the buffer fills to one less than the maximum, then additional keyboard input is ignored until a <RETURN> is typed. The second byte of the buffer is set to the number

of characters received excluding the carriage return (0D hex), which is always the last character. Editing of this buffer is described in the main MS-DOS document under "template editing".

B Check keyboard status. If a character is available from the keyboard, AL will be FF hex, Otherwise AL will be 00.

C Character input with buffer flush. First the keyboard type-ahead buffer is emptied. Then if AL is 1, 6, 7, 8, or 0A hex, the corresponding MS-DOS input function is executed. If AL is not one of these values, no further operation is done and AL returns 00.

D Disk reset. Flushes all file buffers. Unclosed files that have been changed in size will not be properly recorded in the disk directory until they are closed. This function need not be called before a disk change if all files which have been written have been closed.

E Select disk. The drive specified in DL (0=A, 1=B, etc) is selected as the default disk. The number of drives is returned in AL.

F Open file. On entry, DS:DX point to an unopened file control block (FCB). The disk directory is searched for the named file and AL returns FF hex if it is not found. If it is found, AL will return a 00 and the FCB is filled as follows:

If the drive code was 0 (default disk), it is changed to actual disk used (A=1, B=2, etc.) This allows changing the default disk without interfering with subsequent operations on this file. The high byte of the current block field is set to zero. The size of the record to be worked with(FCB bytes E-F hex) is set to the system default of 80 hex. The size of the file, and the time and date are set in the FCB from information obtained from the directory.

It is the user's responsibility to set the record size (FCB bytes E-F) to the size he wishes to think of the file in terms of, if the default 80 hex is not appropriate. It is also the user's responsibility to set the random record field and/or current block and record fields.

10 Close file. This function must be called after file writes to insure all directory information is updated. On entry, DS:DX point to an opened FCB. The disk directory is searched and if the file is

found, its position is compared with that kept in the FCB. If the file is not found in the directory, it is assumed the disk has been changed and AL returns FF hex. Otherwise, the directory is updated to reflect the status in the FCB and AL returns 00.

11 Search for the first entry. On entry, DS:DX point to an unopened FCB. The disk directory is searched for the first matching name (name could have "?"'s indicating any letter matched) and if none are found AL returns FF hex. Otherwise, locations at the disk transfer address are set as follows:

1. If the FCB provided for searching was an extended FCB, then the first byte is set to FF hex, then 5 bytes of zeros, then the attribute byte from the search FCB, then the drive number used (A=1, B=2, etc.), then the 32 bytes of the directory entry. Thus the disk transfer address contains a valid unopened extended FCB with the same search attributes as the search FCB.

2. If the FCB provided for searching was a normal FCB, then the first byte is set to the drive number used (A=1, B=2, etc.) and the next 32 bytes contain the matching directory entry. Thus the disk transfer address contains a valid unopened normal FCB.

Directory entries are formatted as follows:

Location	Bytes	Description
0	11	File name and extension
11	1	Attributes. Bits 1 or 2 make file hidden
10	10	Zero field (for expansion)
22	2	Time. Bits 0-4 = secs/2 5-10 = min 11-15 = hrs
24	2	Date. Bits 0-4 = day 5-8 = month 9-15 = year
26	2	First allocation unit
28	4	File size, in bytes. (30 bits max.)

12 Search for the next entry. After function 11 has been called and found a match, function 12 may be called to find the next match to an ambiguous request("?"'s in the search filename). Both inputs and outputs are are the same as function 11. The reserved area of the FCB keeps information necessary for continuing the search, so it must not be modified.

13 Delete file. On entry, DS:DX point to an unopened FCB. All matching directory entries are deleted. If no directory entries match, AL returns FF, otherwise AL returns 00.

14 Sequential read. On entry, DS:DX point to an opened FCB. The record addressed by the current block (FCB bytes C-D) and the current record(FCB byte 1F) is loaded at the disk transfer address, then the record address is incremented. If end-of-file is encountered AL returns either 01 or 03. A return of 01 indicates no data in the record, 03 indicates a partial record is read and filled out with zeros. A return of 02 means there was not enough room in the disk transfer segment to read one record, so the transfer was aborted. AL returns 00 if the transfer was completed successfully.

15 Sequential write. On entry, DS:DX point to an opened FCB. The record addressed by the current block and current record fields is written from the disk transfer address(or in the case of records less than sector sizes is buffered up for an eventual write when a sector's worth of data is accumulated). The record address is then incremented. If the disk is full AL returns with a 01. A return of 02 means there was not enough room in the disk transfer segment to write one record, so the transfer was aborted. AL returns 00 if the transfer was completed successfully.

16 Create file. On entry DS:DX point to an unopened FCB. The disk directory is searched for an empty entry, and AL returns FF if none is found. Otherwise, the entry is initialized to a zero-length file, the file is opened(see function F), and AL returns 00.

17 Rename file. On entry, DS:DX point to a modified FCB which has a drive code and file name in the usual position, and a second file name starting 6 bytes after the first(DS:DX+11 hex) in what is normally a reserved area. Every matching occurrence of the first is changed to the second(with the restriction that two files cannot have the exact same name and extension). If "?"'s appear in the second name, then the corresponding positions in the original name will be unchanged. AL returns FF hex if no match was found, otherwise 00.

19 Current disk. AL returns with the code of the current default drive (0=A, 1=B, etc.)

1A Set disk transfer address. The disk transfer address is set to DS:DX. MS-DOS will not allow disk transfers to wrap around within the segment, nor to overflow into the next segment.

1B Allocation table address. On return, DS:BX point to the allocation table for the current drive, DX has the number of allocation units, and AL has the number of records per allocation unit, and CX has the size of the physical sector. At DS:[BX-1], the byte before the allocation table, is the dirty byte for the table. If set to 01, it means the table has been modified and must be written back to disk. If 00, the table is not modified. Any programs which get the address and directly modify the table must be sure to set this byte to 01 for the changes to be recorded. This byte should NEVER be set to 00 - instead, a DISK RESET function (#0D hex) should be performed to write the table and reset the bit.

21 Random read. On entry, DS:DX point to an opened FCB The current block and current record are set to agree with the random record field, then the record addressed by these fields is loaded at the current disk transfer address. If end-of-file is encountered, AL returns either 01 or 03. If 01 is returned no more data is available. If 03 is returned, a partial record is available, filled out with zeros. A return of 02 means there was not enough room in the disk transfer segment to read one record, so the transfer was aborted. AL returns 00 if the transfer was completed successfully.

22 Random write. On entry, DS:DX point to an opened FCB. The current block and current record are set to agree with the random record field, then the record addressed by these fields is written (or in the case of records not the same as sector sizes -buffered) from the disk transfer address. If the disk is full AL returns 01. A return of 02 means there was not enough room in the disk transfer segment to write one record, so the transfer was aborted. AL returns 00 if the transfer was completed successfully.

23 File size. On entry, DS:DX point to an unopened FCB. The disk directory is searched for the first matching entry and if none is found, AL returns FF. Otherwise the random record field is set with the size of the file(in terms of the record size field rounded up) and AL returns 00.

24 Set random record field. On entry, DS:DX point to an opened FCB. This function sets the random record field to the same file address as the current block and record fields.

25 Set vector. The interrupt type specified in AL is set to the 4-byte address DS:DX.

26 Create a new program segment. On entry, DX has a segment number at which to set up a new program segment. The entire 100 hex area at location zero in the current program segment is copied into location zero in the new program segment. The memory size information at location 6 is updated and the current termination and <CONTROL-C> exit addresses are saved in the new program segment starting at 0A hex

27 Random block read. On entry, DS:DX point to an opened FCB, and CX contains a record count that must not be zero. The specified number of records (in terms of the record size field) are read from the file address specified by the random record field

into the disk transfer address. If end-of-file is reached before all records have been read, AL returns either 01 or 03. A return of 01 indicates end-of-file and the last record is complete, a 03 indicates the last record is a partial record. If wrap-around above address FFFF hex in the disk transfer segment would occur, as many records as possible are read and AL returns 02. If all records are read successfully, AL returns 00. In any case CX returns with the actual number of records read, and the random record field and the current block/record fields are set to address the next record.

28 Random block write. Essentially the same as function 27 above, except for writing and a write-protect indication. If there is insufficient space on the disk, AL returns 01 and no records are written. If CX is zero upon entry, no records are written, but the file is set to the length specified by the Random Record field, whether longer or shorter than the current file size (allocation units are released or allocated as appropriate).

29 Parse file name. On entry DS:SI points to a command line to parse, and ES:DI points to a portion of memory to be filled in with an unopened FCB. Leading TABs and spaces are ignored when scanning. If bit 0 of AL is equal to 1 on entry, then at most one leading file name separator will be ignored, along with any trailing TABs and spaces. The four filename separators are:

; , = +

If bit 0 of AL is equal to 1, then all parsing stops if a separator is encountered. The command line is parsed for a file name of the form d:filename.ext, and if found, a corresponding unopened FCB is created at ES:DI. The entry value of AL bits 1, 2, and 3 determine what to do if the drive, filename, or extension, respectively, are missing. In each care, if the bit is a zero and the field is not present on the command line, then the FCB is filled with a fixed value (0, meaning the default drive for the drive field ; all blanks for the filename and extension fields). If the bit is a 1, and the field is not present on the command line, then that field in the destination FCB at ES:DI is left unchanged. If an asterisk "*" appears in the filename or extension, then all remaining characters in the name or extension are set to "?".

The following characters are illegal within MS-DOS file specifications:

" / [ ] + = ; ,

Control characters and spaces also may not be given as elements of file specifications. If any of these characters are encountered while parsing, or the period (.) or colon (:) is found in an invalid position, then parsing stops at that point.

If either "?" or "*" appears in the file name or extension, then AL returns 01, otherwise 00. DS:SI will return pointing to the first character after the file name.

2A Get date. Returns date in CX:DX. CX has the year, DH has the month (1=Jan, 2=Feb, etc.), and DL has the day. If the time-of-day clock rolls over to the next day, the date will be adjusted accordingly, taking into account the number of days in each month and leap years.

2B Set date. On entry CX:DX must have a valid date in the same format as returned by function 2A above. If the date is indeed valid and the set operation is successful, then AL returns 00. If the date is not valid, then AL returns FF.

2C Get time. Returns with time-of-day in CX:DX. Time is actually represented as four 8-bit binary quantities, as follows: CH has the hours (0-23), CL has minutes (0-59), DH has seconds (0-59), DL has 1/100 seconds (0-99). This format is easily converted to a printable form yet can also be calculated upon (e.g., subtracting two times).

2D Set time. On entry, CX:DX has time in the same format as returned by function 2C above. If any component of the time is not valid, the set operation is aborted and AL returns FF. If the time is valid, AL returns 00.

2E Set/Reset Verify Flag. On entry, DL must be 0 and AL has the verify flag: 0 = no verify, 1 = verfiy after write. this flag is simply passed to the I/O system on each write, so sts exact meaning is interpreted there.

APPENDIX D

Disk Errors

If a disk error occurs at any time during any command or program, MS-DOS retries the operation three times. If the operation cannot be completed successfully, MS-DOS returns an error message in the following format:

```
<type> ERROR WHILE <I/O action> ON DRIVE x
Abort,Ignore,Retry:_
```

In this message,<type> may be one of the following:

```
WRITE PROTECT
NOT READY
SEEK
DATA
SECTOR NOT FOUND
WRITE FAULT
DISK
```

The <I/O-action> may be either of the following:

```
READING
WRITING
```

The drive <d> indicates the drive in which the error has occurred.
MS-DOS waits entry of one of the following responses:

A Abort. Terminate the program requesting the disk read or write.

I Ignore. Ignore the bad sector and pretend the error did not occur.

R Retry. Repeat the operation. This response is particularly useful if the operator has corrected the error (such as with NOT READY or WRITE PROTECT).

Usually, you will want to attempt recovery by entering responses in the order:

R (to try again)
A (to terminate program and try a new disk)

One other error message might be related to faulty disk read or write:

FILE ALLOCATION TABLE BAD FOR DRIVE x

This message means that the copy in memory of one of the allocation tables has pointers to nonexistent blocks. Possibly the disk was not FORMATted before use.

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